Vol 22

# TRANSACTIONS

# AMERICAN FISHERIES SOCIETY

1893

# TRANSACTIONS

OF THE

AMERICAN

# FISHERIES SOCIETY.

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TWENTY-SECOND ANNUAL MEETING.

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HELD IN THE

MICHIGAN STATE BUILDING,

JACKSON PARK, CHICAGO, ILL.

JULY 15TH, 1893.

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NEW YORK:
John M. Davis, Typographer, 40 Fulton Street.

1893.

## Officers for 1893-'94.

President, HENRY C. FORD.......... .. .... ...*Philadelphia, Pa.*

Vice President, FRED. MATHER...... .....*Cold Spring Harbor, N. Y.*

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Recording Secretary, EDWARD P. DOYLE..........*New York City.*

Cor. Secretary, Dr. J. A. HENSHALL............ *Cincinnati, Ohio.*

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# MINUTES

—OF THE—

# TWENTY-SECOND ANNUAL MEETING

—OF THE—

# AMERICAN FISHERIES SOCIETY.

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## PART FIRST.

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The meeting was called to order by the President, Hon. Herschel Whitaker, of Michigan; the following members being present:

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| A. Booth, | Illinois. |
| L. D. Huntington, | New York. |
| William H. Bowman, | New York. |
| Robert Hamilton, | New York. |
| A. S. Joline, | New York. |
| William C. Butts, | New York. |
| David Decker, | New York. |
| G. Freas, | Pennsylvania. |
| Charles L. Heins, | New Jersey. |
| Henry C. Ford, | Pennsylvania. |
| W. L Gilbert, | Massachusetts. |
| William L. Powell, | Pennsylvania. |
| William F. Page, | Missouri. |
| W. S. de Ravenel, | South Carolina. |
| Dr. Tarleton H. Bean, | Washington, D. C. |
| Frank N. Clark, | Michigan. |
| Herschel Whitaker, | Michigan. |
| Hoyt Post, | Michigan. |

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|---|---|
| Dr. Jacob Reighard, | Michigan. |
| William L. May, | Nebraska. |
| Edward P. Doyle, | New York. |
| Charles Wyeth, | New York. |
| Fred Mather, | New York. |
| Dr. J. A. Henshall, | Ohio. |
| Dr. H. H. Cary, | Georgia. |
| H. W. Davis, | Michigan. |
| W. David Tomlin, | Minnesota. |
| C. E. Armstrong, | Ohio. |
| Joseph H. Blair, | Nebraska. |
| J. C. Parker, | Michigan. |
| J. W. Collins, | Washington, D. C. |
| James Nevins, | Wisconsin. |
| John Gay, | Pennsylvania. |
| B. R. Vincent, | Ohio. |
| Dr. R. O. Sweeny, | Minnesota. |
| Dr. Nicholas Borodine, | Russia. |
| Asa French, | Massachusetts. |
| Dr. William M. Hudson, | Connecticut. |
| H. C. Demuth, | Pennsylvania. |
| L. Streuber, | Pennsylvania. |

After the roll was called, the President addressed the members as follows:

GENTLEMEN OF THE AMERICAN FISHERIES SOCIETY:

We meet to-day to participate in the work that may properly come before us at our twenty-second annual gathering. While the Society changed its name some years since from the Fishcultural Society to its present name of the American Fisheries Society, its personnel remains practically the same as before the change, and notwithstanding its change of name may be considered as having had one continuous existence from its original inception. The object sought in the change of name was to give to the title under which it was known a broader and more comprehensive scope, and to admit not only those who were fishculturists but those who, while not actively engaged in fishcultural work, were interested and active workers in matters closely allied with fishculture. The wisdom of the

change has been fully justified by the addition of such persons, who have proven useful members.

The formation of the Society was coeval with the introduction of practical fishculture into this country, and the necessity of such an organization as a useful aid to fishculture, in the opinion of those who organized it, has been fully justified by its history. Its originally expressed object was to bring together, for consultation and into closer relationship, those who were interested in fishculture, directly and indirectly. Those purposes have been fully subserved by the Society in all its past history, and the published records of its proceedings from year to year furnishes a record of the current advance that has been made from year to year in the work of artificial propagation, the stocking of waters and the advance in fishcultural work. The papers submitted at its meetings on subjects of interest have been of great value, elicited discussion, and brought out new ideas which have been of advantage.

There is perhaps no country in which the importance of fishculture has been so generally recognized as in the United States. The commercial value of our sea and lake fisheries is very important, and the decay resulting from a long and protracted course of fishing, first challenged attention of the people to the institution by means of which the waste might be corrected and the loss made good. The general Government and the State Governments more than twenty years ago recognized the benefits to be derived from the work of artificial propagation, and at once commenced the establishment of hatcheries, and have since liberally voted money for the establishment and maintenance of fishcultural work in the various States.

The work of the Fish Commissions in this country has up to this time been mainly directed to the propagation and planting of fish in the sea, lakes and streams. This work has been most successful, and the waters thus planted are a standing object lesson of the value of this undertaking.

It would seem, however, when we come to consider the status of the work of our different Commissions, and the progress they have made in the propagation of commercial fish, that the time has now come when Commissions should, in connection with their other work, take up the equally important matter of investigation into the food of the fishes, and should direct their attention to this subject, which is of the highest importance to the success of all fish-cultural work.

While something has already been done in this direction in this country, the work has been of a rather desultory and fugitive character, and has not been carried out upon a well-considered plan. We grant that it is important that the fishculturist should hatch fish, and hatch them in large numbers, but is it not of equal importance that he should know the character and amount of the food of young fish contained in the waters in which they are put? Is it not of greatest consequence that he should know whether this food abounds more plentifully in one locality, or at one season of the year than at another? Is it not material to the success of his work that the fishculturist should know whether his "presumption" that the food of the young fish is to be found plentifully upon the natural spawning beds should be verified, and if it is not so, where it may be found in greatest abundance? This being admitted, is it not essential that he should know the precise localities of every spawning bed of the commercial fish beyond a doubt? In other words, our information should not depend upon uncertain information that is based upon the local traditions of practical fishermen as to the location of spawning beds. While such information may be sufficiently accurate for the fisherman's purpose, it may be absolutely worthless to the fishculturist in determining their exact location. In the trial of a suit at law, secondary or hearsay evidence is never admissible to determine a fact, and yet the admission of such evidence in a law suit would not be productive

of half the evil which would follow such poor proof of so important a fact to be determined in the work of a Commission which seeks to do its work effectively. Then, too, why should not the fishculturist know more nearly and exactly by sight the whitefish and other commercial fish of our great lakes at every stage of their growth, from the fry age to that time when their identity can be easily established by the most casual observer? With such knowledge, we might know with greater certainty the rate of growth of these fish, and we might also be able to definitely determine their movements in the great lakes throughout the entire year. It would be of interest and a valuable addition to our knowledge, to know how long the young fish remain upon the spawning beds, and at what period they leave them, where they go in search of food, and upon what they live after leaving them. These and other matters of equal importance challenge the attention of thoughtful fishculturists, who keep in view a successful result of their work; and it is clearly not only within the province of the fishculturists and of Fish Commissions to settle these questions, but it is their clear duty. The successful solution of these matters will serve to equip us with valuable information that will aid largely in arriving at the best practical results at which we aim.

Greater attention should also be given to the planting or stocking of our inland waters, and the manner in which this work shall be performed. Systematic and comprehensive examinations should be made of the lakes and streams, to determine their character, temperature, depth and the character of the fish food which they sustain. Too much stress cannot be laid upon the value of such examination. Only by this method of inquiry can intelligent stocking of waters be done. The fishculturist who wishes to act for the best interests of his work must act intelligently in making his distributions. The character of the work in which he is engaged and its results depend upon his care

in making his plants, and if he knows his waters, what they contain, and for what they are suited, he can secure a larger measure of success.

This work of examination, if carefully made and correctly reported and filed, is invaluable for future reference, and is of the greatest aid in making future distributions. A reference to such report at once discloses whether the kinds of fish applied for are fitted for the waters mentioned in the application. If they are not, the grounds of refusal are at hand by which the applicant may be convinced of his mistake, and fish suitable for his waters can thus be furnished him.

The attention of most of our Fish Commissions has up to this time been chiefly directed to the propagation and distribution of the finer edible varieties of fish of the salmon family. The ova of these fish is easily treated, and presents but few obstacles to their manipulation, and a large percentage of fertilization is secured. No fault can be found with the carrying on of this work, and it is of the utmost importance that it should be continued and enlarged, but we should not rest contented with this work alone. A broader field than this is open to the fishculturist, and cannot be entered upon too soon. Many of our spring spawning fish are of great value commercially, others of excellent quality are objects of the angler's pursuit, and are among the best fish which our inland waters produce. The exceeding viscidity of their ova presents difficulties to successful handling when artificially impregnated, but the value of these fish, and the necessity that they should be objects of the fishculturist's attention, should urge us to give them the attention they demand. The physical difficulties to be overcome in the treatment of the ova renders it difficult and sometimes discouraging to the operator, but these difficulties it is the duty of the fishculturist to overcome. The popularity of the small-mouthed black bass as the game fish of our inland lakes

and streams, has led to an over-fishing in some of our older States, and in our most accessible waters, and a consequent scarcity of fish. This fish is worthy of the best attention of Commissioners, and should receive attention at our hands.

In overcoming the difficulties I have spoken of, and the resulting low percentage of success which has attended such few experimental efforts as have been made, we can with profit call in the co-operation of the scientist to aid our practical force of fishculturists, who will tell why they meet with only partial success in present methods in the manipulation of the fish and the treatment of the ova. He will be able to point out, with the aid of the microscope and a higher education and sharpened intelligence, the causes which result in low impregnation, and the way in which present methods may be improved.

Much has been done in the past few years in attempts to successfully introduce into our waters foreign species of fish, and while these efforts should not be too harshly criticised, it may be said that outside of one or two varieties thus introduced, this work has been unsuccessful. The experiments have been of but little practical value when we count results. It must appeal to the average judgment after all, it would seem, that if an equal amount of effort, time and means had been devoted to the increase of the native fish which we have that are deserving of care and attention and multiplication, the money, time and effort would have been more practically spent. These indigenoush fish are natural to our waters, are of excellent character; it is no experiment to determine whether they will live and thrive. They do not require to be adapted to strange conditions and new surroundings. Is it not better practical fishculture to increase the good varieties that we have, than to go too far into the field of experimentation? It would seem that the office and function of a Fish Commission is best fulfilled when it gives its attention to the

increase of those fish natural to our waters, rather than to attempt to solve unsolvable or difficult questions which have but little practical value.

The probabilities of fishculture in America are great. With well-directed effort, every lake, stream and river can be made to produce a plentiful supply of fish, which are best suited to their condition, thus furnishing a large and important supply of food which will not require the hand of man to assist in its cultivation. To accomplish this purpose, it seems to me, is the enlarged field which every Commission is invited to enter. This is the field which modern fishculture, based on enlarged ideas of public work, may occupy with profit. The American Fisheries Society is the proper forum in which these and kindred questions should be mooted and discussed. Modern fishculture needs to take another step in advance, and if it shall live up to its possibilities, the members of this Society, at their annual gathering two decades hence, will point to a far greater advance in the work of fishculture than we have accomplished in the two decades that have just passed.

Henry C. Ford, of Pennsylvania, the Treasurer of the Association, then presented his annual report, which, upon motion, was referred to an Auditing Committee of three, to be appointed by the Chair; the Chair appointed as such Committee: Henry H. Cary, of Georgia, John Gay, of Pennsylvania, and J. E. Gunckel, of Ohio. The Recording Secretary then presented his annual report, which, upon motion, was ordered printed upon the minutes. The report was as follows:

Gentlemen of the American Fisheries Society:

During the past year the Society lost six members by death and eight by resignation; forty-nine new members were elected; the present membership is, corresponding members 30; honorary members 6; active members 255.

Agreeable to your resolution of last meeting, I notified the Commissioners of Fisheries of each State in the Union that they had been elected members of the Society, by virtue of the offices they held. In my letter I requested that they answer my communication, accepting or declining membership. The answers received were all favorable, and every Fish Commissioner of the United States is now a member of the American Fisheries Society.

Circulars were also sent out liberally to all persons interested in fish and game, but the responses were but few. It is very desirable that the membership of the Society shall be increased, and means to that end should be at once taken. As the membership of the Society grows larger, the circle of its influence will widen, and the sphere of its usefulness extend. It can be made the most important factor in the advancement of fish and game interests of the country.

EDWARD P. DOYLE,
*Secretary.*

On motion, the report was received and referred to a special committee of three, to be appointed by the President, with full power to act in the premises. The President appointed as such Committee Dr. H. H. Cary, of Georgia, John Gay, of Pennsylvania, and J. E. Gunckel, of Ohio.

The reading of papers then began. The first paper read was by Fred Mather, Superintendent of the Cold Spring Harbor Station of the New York Fish Commission, and was entitled "What we Know About Lobsters." The discussion aroused by this and subsequent papers will be found printed in the Appendix to the report. The next paper was by J. D. Quackenbos, A.M., M.D., on the Sunapee Saibling. The next paper was by Hon. Hoyt Post, of Michigan, entitled "An Historical Review of Fish Culture in Michigan." Prof. Jacob Reighard then read a paper entitled "Handling of Adhesive Eggs." A paper by W.

David Tomlin, entitled "The Specialist in Fish Culture," was announced by title but not read.

William F. Page, of Missouri, read a paper entitled "Plant Yearlings Where Needed." At this point, the reading of papers was suspended, and on motion, W. L. May, of Nebraska, L. D. Huntington, of New York, and W. H. Davis, of Michigan, were appointed a Committee to consider the question of the selection of a place for the next meeting of the Society. Hon. L. D. Huntington offered the following resolution, which, upon motion, was unanimously adopted:

*Resolved*, That there be entered upon the minutes of this meeting an expression of the thanks of this Society to the World's Fair Commissioners of the State of Michigan for their kindness in allowing the Society the use of so spacious a room for their meeting.

A paper by E. W. Gould, who was absent, was announced to be read by title. This occasioned considerable discussion, and upon motion, it was *Resolved*, That papers read by title be referred to a Committee on Publication, consisting of three, the President, the Secretary, and another, to be appointed by the President.

A paper was then read on Pearl Fisheries by Prof. Kunz. On motion, it was *Resolved*, That the paper of Prof. Kunz be printed with illustrations. On motion, a committee of five was appointed to present nominations for officers for the Society, for the ensuing year, the committee to be appointed by the President. The President appointed as such Committee, Dr. H. H. Cary, of Georgia, William H. Bowman, of New York, John Gay, of Pennsylvania, R. O. Sweeny, of Minnesota, W. L. May, of Nebraska.

On motion, a recess was taken until 2.30.

ADJOURNED MEETING AMERICAN FISHERIES SOCIETY, HELD IN JACKSON PARK, CHICAGO, THURSDAY, JUNE 15TH, AT 2.30 P. M.

Immediately after the meeting was called to order, the

President informed the Society that Capt. J. W. Collins, Chief of the Department of Fish and Fisheries, had invited the members to visit the Fisheries Building. Capt. Collins said that the Russian Commissioner would show and explain his collection. He also desired to call especial attention to the rare exhibit of fish and boats, never before seen at former Expositions. The President also announced that Mr. Kunz, of Tiffany & Co., who read a paper on Pearl Fisheries, invited the Society to visit the exhibit of Tiffany & Co., and examine the collection of Oriental pearls. On motion, both invitations were accepted :

The Committee appointed to audit the accounts of the Treasurer, then presented the following report :

AMERICAN FISHERIES SOCIETY
IN ACCOUNT WITH
H. C. FORD, Treasurer, June 1st, 1893.

| | | | |
|---|---|---|---|
| 1892. | *Credits.* | | |
| May 25. | By balance on hand.............. | | $217.73 |
| | By cash, dues received from members to June 1st, 1893......... | | 321.00 |
| | Total....................... | | $538.73 |
| 1892. | *Debits.* | | |
| May 25. | To cash paid E. P. Doyle, for disbursements...... | $ 15.65 | |
| June 13. | To cash Spangler & Davis, for printing........... | 1.25 | |
| July 8. | John Standfast, stenographer................... | 50.00 | |
| Aug. 6. | Mary Walling, typewriter | 37.67 | |
| Oct. 10. | D. S. Walton & Co., for sundry bills .......... | 20.80 | |
| Dec. 23. | D. S. Walton & Co., for printing report........ | 343.00 | |
| 1893. | | | |
| Jan. 20. | Postage stamps, etc...... | 3.50 | |
| June 1. | Balance in hands of Treas. | 66.86 | $538.73 |

The Auditing Committee having examined the above report, and accompanying vouchers, find the same correct.

All of which is respectfully submitted.

H. H. CARY, Chairman,<br>JOHN GAY,<br>J. E. GUNCKEL, } Auditing Committee.

The following papers were then read; "A Statistical Review of Fish Culture in the United States and in Europe," by Dr. Nicholas Borodine, of Russia. A paper on "Norwegian Fisheries" was read by Chr. Ravn, Royal Commissioner from Norway.

On motion, a recess was taken until 2.30 in the afternoon.

MINUTES OF ADJOURNED MEETING AMERICAN FISHERIES SOCIETY, HELD FRIDAY, JULY 16TH, AT 2.30 P. M.

After the meeting was called to order, Dr. Cary, from the Committee on Nominations, presented the following report:

"Your Committee on Nominations beg leave to submit the following names as candidates for officers of the Society for the ensuing year: For President, Henry C. Ford, of Pennsylvania; for Vice-President, Fred Mather, of New York; for Treasurer, R. Ormsby Sweeny, of Minnesota; for Recording Secretary, Edward P. Doyle, of New York; for Corresponding Secretary, Dr. J. A. Henshall, of Ohio. Executive Committee: H. H. Cary, La Grange, Ga.; L. D. Huntington, New Rochelle, N. Y.; L. Streuber, Erie, Pa.; W. L. May, Omaha, Neb.; James Nevin, Madison, Wis.; J. E. Gunckel, Toledo, O.; A. B. French, South Braintree, Mass.; Herschel Whitaker, Detroit, Mich."

On motion, the report of the Committee was received and adopted, and the persons named unanimously chosen as officers for the Society for the ensuing year.

Dr. Tarleton H. Bean presented the following resolution, which, upon motion, was lost:

"*Resolved*, That nominations of officers of the American

Fisheries Society be made in open meeting and that elections be had by ballot."

The Recording Secretary called attention to the fact that he had inadvertently printed in the preceding report a paper by Charles F. Chamberlain, of Massachusetts, reflecting upon several members of the Society.

On motion, a resolution of thanks was adopted, thanking Capt. J. W. Collins for the excellent dinner he had provided for the members.

Mr. Huntington, of New York, from the Committee on Site and Date for the next meeting, reported in favor of Philadelphia as the place of meeting, and the third Wednesday in May as the date. Dr. Tarleton H. Bean, of Washington, moved a division of the question, which was carried. The question then was, "Shall Philadelphia be adopted as the place of meeting?" The question was carried. The third Wednesday in May was then adopted as the time for the meeting.

The following gentlemen were then elected members of the Society: Honorary, Nicholas Borodine, Delegate of the Russian Association of Pisciculture and Fisheries, St. Petersburg, Russia. Active members, Dr. Bashford Dean, Columbia College, New York; C. E. Armstrong, Toledo, Ohio; Joseph H. Blair, Omaha, Nebraska; W. de C. Ravenel; Alexander Jones, Wood's Holl, Massachusetts; H. W. Davis, of Detroit, Michigan.

PAPERS READ BEFORE THE

# AMERICAN FISHERIES SOCIETY,

## WITH THEIR DISCUSSIONS,

JULY 15TH, 1893.

## PART SECOND.

### ON THE OCCURRENCE OF PEARLS IN THE UNITED STATES, AND SHALL WE LEGISLATE TO PRESERVE THE FISHERIES.

BY GEORGE FREDERIC KUNZ.

Pearls are lustrous concretions, consisting essentially of carbonate of lime interlaminated with animal matter, found in the shells of certain mollusks. They are evidently a result of an abnormal secretory process caused by an irritation of the mantle of the mollusk consequent on the intrusion into the shell of some foreign body, as a grain of sand, an egg of the mollusk itself, or perhaps a cercarian parasite. It has also been suggested than an excess of carbonate of lime in the water may cause the development of the pearl. Accepting the former theory as the more probable one, it is easy to understand how a foreign body, which the mollusk is unable to expel, becomes encysted

or covered as by a capsule, which gradually thickens and assumes various forms—round, elongated, mallet-shaped, and sometimes as regular as though it had been turned in a lathe. It is suggested that the mollusk continually revolves the enclosed particle in its efforts to rid itself of the irritation, or possibly that its formation is due to natural motion, which is accelerated by the intruding body.

In regard to the formation of pearls the following general statements may be made: Whatever may be the cause, or the process of their production, these interior concretions may occur in almost any molluscan shells, though they are confined to certain groups, and their color and lustre depend upon those of the shell interior, adjacent to which they are formed. Thus the pink conch of the West Indies yields beautiful rose-colored pearl shells consisting of three strata: first, the outer yellow or brown conchioline (cuticula or epidermis); second, the prism stratum, consisting of layers formed of minute prisms arranged vertically to the layers and the shell surface; and third, the interior nacreous layer, composed of finely folded leaves parallel to the surface of the shell. The last two strata consist chiefly of carbonate of lime. These formations were illustrated by transverse cuttings and microscopic sections. When a wound has been received by the animal in any soft part, the tissues become moistened with a lime-like material, and especially with the nacre substance. This often happens in the muscles which serve to close the shell, and the irregular concretions thus formed are called "sand pearls." When the growth of the pearl is abnormally strong, the pressure which it exerts on the outer wall of this tissue-pocket becomes so powerful that the pocket is absorbed on the side toward the shell, bringing the hard pearl directly against the latter. It then becomes impossible for the pearl to grow any more at the point of contact, for there is no tissue to secrete the lime substance; but it grows on the rest of the surface, and the

thickening layers, as they are formed, pass directly into the nacre layers on the inside of the shell, and thicken the shell itself. Through these over-layers the pearl is connected with the shell as though by a succession of covering clothes. At first it clings to the shell at one point only, afterward enlarging the area of its adhesion. In this manner twin or united pearls are formed. Whatever be the method of their formation, it would seem that pearls can be formed only at the expense of the shell, for every substance necessary to their growth is drawn from sources which normally secrete the shell. Hence the presence of the pearl can usually be detected on the outside of the shell. Normal appearing shells rarely contain pearls, while on the other hand those that are deformed often contain pearls of great beauty. There are three indications on which pearl-fishers rely for detecting from the outer aspect of the shell the presence of pearls. These are: first, the thread, that is, the recess of elevation extending from the vertex to the edge; second, the kidney-shape of the shell, that is, an indentation on the ventral side; and third, the contortion of both shells toward the middle plane of the animal.

The families with iridescent interior layers are the following: Among cephalopods, the Nautilus and Ammonite groups, the latter wholly fossil, and among gasteropods, the Turbo and Haliotis families. In all these forms, the removal of the outer layers of the shell reveals the splendid pearly surface beneath. Such shells, thus "cleaned" with dilute acid, are familiar as ornamental objects, while those of the common oyster and clam are dead white or dark purple, according to their proximity to the part of the mantle which secretes the white or the dark material of the shell. The true pearly or nacreous (iridescent) interior belongs to only a few families of mollusks, and in these alone can pearls proper be formed at all; while in

point of fact they are obtained only from a very few genera of shells.

None of the air-breathing mollusks (the land snails) produce a nacreous shell; and among fresh-water mollusks none are pearl-bearers, except certain of the bivalves, notably those belonging to the group appropriately called the Naiades, of which the common river-mussel (Unio) is a typical example. The soft internal parts of these mollusks are covered by a thin, delicate membrane called the mantle, from the surface of which and particularly from its outer edge, material is excreted to form the inner layers of the shell. The shell consists of two parts, the epidermis and the shell proper, the latter composed of numerous layers. The epidermis, which resembles horn, is chiefly composed of a substance called "conchioline," and is soluble in caustic alkalies.

The pearls of commerce, however, are almost wholly obtained from bivalve (lamellibranch) shells, of which the following families have a nacreous lining: Aviculidæ, Mytilidæ and Unionidæ, the latter being wholly fresh-water shells, also known as the Naiades. A few families of other genera are also brilliantly pearly, but need not be here discussed. The true pearl oyster (Meleagrina) of the Pacific and Indian Oceans belongs to the first of these groups, and has from time immemorial yielded the bulk of commercial pearls, while its large and thick shell furnishes the mother-of-pearl for countless ornamental purposes.

The Naiades are of particular interest in this country, as it is in North America that this group is the most abundant, and it is only of the occurrence of pearls, and the preservation of the fisheries of the United States, that my paper will treat. Many hundred species of Unio, Anodon, etc., have been found in our great rivers and lakes; the Mississippi basin teems with them; for the most part in forms quite distinct from those of the Atlantic

water-shed and of the Old World. The Unios, while all iridescent, vary greatly in tint, exhibiting all the delicate shades of pink, brown, purple, etc., as well as white. The rivers of Europe, of Mesopotamia and of China, also yield large numbers of Unios; while the allied genera Hyria and Castalia are found in the rivers of South America.

The same causes and operations that result in the production of pearls, or free nacreous concretions in the soft animal substance of the pearl-oysters or mother-of-pearl shells, also produce in a modified way the tuberculous or knob-like protuberances and irregularities of surface that are frequently seen on the pearly inner surface of the valves and projecting therefrom. The flatter or less pronounced forms of these nacreous excrescences are often called "blister pearls," because of their resemblance to vesicular eruptions, or water blister, caused by burns.

Fresh-water pearls are found, as before stated, in various species of Unios, more frequently, according to Dr. Isaac Lea, in the Unio complanatus, but also in the following: U. blandianus, U. buddianus, U. costatus, U. elliotti, U. fragilis, U. globulus, U. gracilis, U. mortoni, U. nodosus, U. orbiculatus, U. ovatus, U. torsus, U. undulatus and U. virginianus. Not one pearl in a hundred from the Unios is of good shape, and probably not more than one in a hundred is really fine; therefore, as the worth of a pearl depends on lustre and form, the greater number obtained from this source are of slight value.

A hundred pearls have been found in a single shell; but as a rule these have little or no value. Very curious nacreous groups made of many small pieces are at times found attached to the hinge, but these are generally without sufficient lustre to be of value, and are rarely collected. These groups are caused by the aggregation of many small ones cemented by a deposit of nacre, and are often half an inch across.

In color, the Unio pearl presents an extended series of

shades, from dead opaque white, having but little value, through various tints of pink, yellow and salmon, passing through a more decided form of these colors, or a faint purple, into a bright red, so closely resembling a drop of molten copper as almost to deceive the eye. Some are very light green and brown, others rose-color, and still others are pale steel-blue, or russet and purplish brown. The white and the pink pearls are exceedingly beautiful, and the finest, owing to their delicate sheen or layers, are at times more lustrous than even the best oriental pearls. This lustre is increased by their greater transparency, and a really fine white, pink, yellow or iridescent pearl is often found quite translucent. In addition to their color and lustre, they are beautifully iridescent. They are found in many odd and remarkable shapes.

Elongated fish-like forms, formed and found near the hinge of the shell, and called hinge baroque pearls, are abundant. Others, with but a slight addition of gold and enamel, seem to represent human and animal heads, bat and bird wings, and similar objects. Mallet-shaped pearls are found with fine color and lustre at each end, but generally with opaque sides; also grouped or bunched masses of pearly nacre, made up of from one to over one hundred distinct pearls in fanciful shapes, are of occasional occurrence. Feather-like forms with curiously raised points, and an odd, rounded variety with raised, pitted markings, are quite abundant. A pearl was mounted in this country that strikingly resembles the bust of Michael Angelo, and a number of unique designs have been made of baroques, similar to those mounted by Dinglinger and exhibited in the Green Vaults at Dresden. Although the pearls used here have not been as large as those shown in Dresden, greater taste has been employed in mounting them. The variety of the forms being so great, an artist has a wide field for imagination. The pearls, however, have but slight value unless they are beautiful and lustrous.

Frequently pearls have an opaque appearance and seem to be worthless, but upon the removal of their outer layer are found to be clear and iridescent. This outer layer may be removed by dipping them in a weak solution of acid, which dissolves the opaque coating, or it may be peeled with a knife; although sometimes the pearl is not of the same material throughout and cannot be.

That conchologists make so few references to pearls is probably accounted for by the fact that the pearls are contained in old, distorted and diseased shells, which are not so desirable for collections as the finer specimens. Collectors who have opened many thousands of Unios have never observed a pearl of value.

Large and valuable Unio pearls have been obtained in New Jersey. In 1857 a pearl of fine lustre, weighing 93 grains, was found at Notch Brook, near Paterson. It became known as the "Queen Pearl," and was sold by Tiffany & Co. to the Empress Eugenie of France for $2,500. It is to-day worth more than four times that amount, and is finer than any pearl shown at the 1893 World's Columbian Exposition. The news of this sale created the first great pearl excitement that led to the search for pearls which spread westward throughout the country. The Unios at Notch Brook and elsewhere were gathered by millions and destroyed, often with little or no result. A large round pearl weighing 400 grains, which would doubtless have been the finest pearl of modern times, was ruined by boiling open the shell.

Within one year pearls were sent to the New York market from nearly every State. In 1857 fully $15,000 worth; in 1858 about $2,000; in 1859 about $2,000; in 1860 about $1,500; in 1868, when there was a slight revival of interest, and since then, many Little Miami River pearls have been found. Since 1860, pearls have come from a comparatively new district, the supply from which is apparently on the increase. At first few were found, or rather few were

looked for, west of Ohio; but gradually the line has extended to Kentucky, Tennessee and Texas; and now Wisconsin is the principal pearl-producing State; while some pearls are sent from Florida, Nebraska and Washington State.

Some of the earliest American pearls that were found came from near Waynesville, Ohio; $3,000 worth having been collected in that vicinity during the pearl excitement in 1878. At that time Israel H. Harris, of Waynesville, began what has since become one of the finest and best known collections of Unio pearls in this country, purchasing, during many years, every specimen of value that he could find in that part of the State. Among his pearls was one button-shaped on the back and weighing 38 grains, also several almost transparent pink ones, and an interesting specimen showing where a pearl had grown almost entirely through the Unio shell. His collection contained more than 2,000 pearls, weighing over 2,000 grains, and is in all probability the last collection that will be made from that district. It was exhibited in the Jewelry Department at the World's Fair in Paris, in 1889.

A pearl from Montpelier, Vermont, was sold for $300; one from Waynesville, Ohio, valued at $200; one from Boston, Texas, valued at $250; one pink pearl, 19½ grains, from Murfreesborough, Tennessee, valued at $80, another at $150; one from Llano, Texas, valued at $95, have been sold in New York.

The production during recent years has been as follows:

September, 1881 to 1882..........210 lots worth $7,500
September, 1882 to 1883......... 72 lots worth $5,000
September, 1883, to August, 1884, 71 lots worth $5,000

American pearls, until within the past few years, were generally sold at a figure below their real value, and the values of the above to-day would be fully two or three times those amounts; and at present the local value is often exaggerated several times above their true value.

Since 1889, pearl fishing in Wisconsin has been extensively carried on along the Pecatonica River and the creeks emptying into it, principally between Darlington and Argyle, Lafayette County, as well as on Apple River. Many fine pearls, remarkable for brilliancy and lustre, have been obtained, among them some of the finest copper-colored, russet, purple and rich pink tints ever found. Some simple pearls weigh over 50 grains, and the finest ones command from $500 to over $1,000 each. It has been estimated that over $300,000 worth of pearls have been found in the course of the past few years; the pearls frequently commanding higher prices here than the oriental pearls, and as a result, pearls sent abroad were returned, the prices being abnormally higher than the foreign markets would pay.

Some of the finest pieces of jewelry shown at the World's Columbian Exposition were made of American pearls and American precious stones. A fine collection was on exhibition in the Wisconsin Exhibit of the Mines and Mining Building, World's Columbian Exposition; the value of this collection was estimated at over $100,000; but the prices were somewhat fancy ones, induced by local demand.

During the summer of 1890, the pearl excitement extended to Marnitowoc County, Wisconsin, and numerous small lakes that lie iu Calumet County. From one to fifty pearls have been found in a single Unio. When numerous, they are usually hinge pearls. As in the former times of excitement, hundreds of men, women and children made trips to these creeks; the men and boys removing the shells from the river, while the women and girls opened them.

In the same year the pearl-hunting fever extended along the Mackinaw River and the creeks running into it in McLean, Tazewell and Woodford Counties, Illinois. Pearls have also been found in the vicinity of Traer and Geneseo,

on Wolf Creek, Iowa. A fine pink pearl was found near Walla Walla, Washington State, and a number have been sold at Seattle, Washington.

One of the most singular circumstances connected with the New Jersey "pearl fever" of 1856 was the discovery of several shells which proved that the local savants had experimented on the pearl-bearing Unios by dropping mother-of-pearl buttons inside the shell, hoping that the mussel would cover them with its secretions. The specimens found had apparently been experimented on over 30 years before, at a time when European scientists were greatly interested in shells received from China, containing small images of Buddha. These images were moulded in tin and placed between the mantle and the shell. The mussels were then returned to their natural environment, and after several months the layer of mother-of-pearl became of sufficient thickness, and the images were removed.

In a shell of the Lea Collection of Unionidæ, which has recently been presented to the United States National Museum, an oval piece of white wax, flat on the lower side and rounded on the upper, which had been inserted in the valve near the hinge, is entirely coated with a pink nacre. It has been broken out of the shell, the pearly nacre of the lower or flat side remaining in the shell; whereas the dome-shaped piece is covered with this material.

The writer knew a New York lady who purchased a button-shaped Unio pearl that had a black, diseased appearance on one side. It was so set that the imperfection was all below the mounting. When applauding at the opera one evening, the pearl was broken, and upon examination it was found to consist of a very thin nacreous layer, inside of which was nothing but a hard, white, greasy clay.

At the International Fisheries Exhibition held in Berlin during 1880, there were shown results of experiments under-

taken in Germany, toward the production of artificial pearls from Unios, in a manner similar to that practiced by the Chinese. Flat tin figures, usually of fish, were introduced between the mantle and the shell. Similar experiments were conducted in the Royal Saxon pearl fisheries. Either small foreign bodies were introduced into the mantle, in order to furnish the nucleus for the free pearl formation, or the Chinese method of inserting such bodies between the mantle and the shell, was followed. From the second method successful results were shown. The foreign bodies that had been introduced were poor pearls from other mussels, pieces of grain, or china buttons, and were entirely covered with nacreous substance. The shape of these objects makes it impossible for the mantle to fit closely around them, and hence the nacre covers them so irregularly that little or no use can be made of them, and ornamental devices coated with a beautiful nacre would undoubtedly find ready purchasers at a fair price. From specimens exhibited, it was shown that German oysters could be made to cover a plain relief with nacre, as well as those of China. The cultivation of such forms in this country might lead to considerable income; and the brooks could be as easily protected as trout brooks or ponds are.

Efforts to make the river pearl mussel available in another way met with better success, and are worthy of consideration in the United States, and may lead to a new industry. In 1850, Moritz Schmerler conceived the idea of making small fancy articles of the shells themselves, and succeeded so well that the German Government allowed him to take from the Royal beds the shells needed for his manufacturing business. Large numbers of pearl shell pocket-books and hand-satchels have been made since then. The almost faultless white and reddish tinted "rose-pearl mussels" are specially prized for this purpose, as the material may be cut so thin that a photograph

pasted on the inside can be seen through the shell, conveying the appearance of being produced on the shell itself. Other manufacturers engaged in the business, as soon as its success became apparent, and many hundred thousands of pearl mussels are now annually used at Aldorf, where the business is chiefly carried on. The principal sources of supply are brooks in Bavaria and Bohemia that are owned by private persons. Why not Tennessee, Wisconsin and Texas ?

Pearls are usually found either by farmers, who devote their spare time to this industry, and, if no result is obtained, suffer no loss, or by persons in country villages who are without regular occupations, but are ever seeking means for rapid increase of fortune. Many shells that do not contain pearls are destroyed. In order to obviate this

FIG. 10. METHOD OF OPENING MUSSELS IN SAXONY IN ORDER TO SEE IF THEY CONTAIN PEARLS.

wholesale destruction, it would be well to give the industries a legal protection, making it punishable by fine to kill a Unio, and requiring all pearl-fishers to use instruments like those that are employed in Saxony and Bavaria. (See illustration, "Gems and Precious Stones of North America," New York, 1893; Figs. 10 and 11, page 232.)

In the former country a thin flat iron tool with a bent

end is inserted into the shell. The handle is then turned 90 degrees and the shell is opened without injury to the animal. Another instrument is a pair of pliers with sharp-pointed jaws, and a screw between the arms, which isturned by the hand until the valves of the shell are sufficiently distended to see whether it contains a pearl. If it does not, the animal is returned to its former haunts, perhaps to propagate more valuable progeny. In gathering the shells, only those that are full-grown, old and distorted by disease should be taken, and these only opened and not destroyed, so that the fisheries may be preserved; and the shells should be opened as soon as taken from the water, and not allowed to open by decay, for this discolors the pearls; and particularly, they must never be opened by boiling water, as this dims the lustre and lessens the value of the pearl. Many lakes and rivers, among them the Olentang at Delaware, Ohio, and a number of streams near Columbus, have been completely raked and scraped, often in a reckless manner, and consequently with very little result. The general method of collecting shells was for a number of boys and men to wade into the mill-race or into the river to their necks, feeling for the sharp ends of the Unios, which always project. When one was discovered in this manner, the finder would either dive after it or lift it with his feet. It was the custom at that time to open the shells in the water, and once during the process a pearl, the size of a pigeon's egg, is said to have been dropped into the water and never recovered.

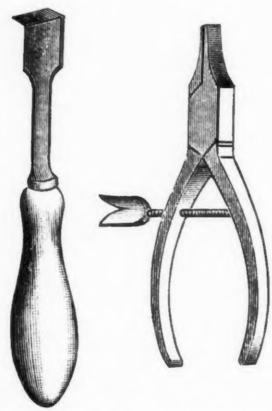

FIG. 11. INSTRUMENT USED IN SAXONY TO OPEN MUSSELS WITHOUT KILLING THEM.

This wholesale destruction, together with the depredations of hogs, which have exterminated whole shoals of Unios when the water in the brooks was low, and the substances introduced into the water by manufacturing industries, besides sewerage and refuse from factories, are rapidly causing the disappearance of animal life from many of our water courses.

It is probable that the existence of carbonate of lime in excess where mussels abound, influences the secretion that causes the growth of the pearls. In lime-stone regions, if the waters are polluted by products of decomposition that are acid, these unite with the lime and form other compounds, which are either precipitated or carried away with the impurities of the water. There can be no doubt that this cause would tend to decrease the amount of lime which the shell would receive, thus not only retarding the growth of the pearls, but often eventually leading to the extermination of the Unios themselves. At nearly all the marine pearl-fisheries, coral-banks abound; branches of coral frequently forming on the shells themselves, sometimes three or four species on a single shell; and it may be that these have more or less influence on the development of the pearl in the shell. In Vermont, New Jersey and Ohio, where pearls were formerly found, a fine one is now rarely obtained.

A unique method of collecting Unios is that practiced by the lumbermen, who, while sailing down the Canadian rivers on their rafts, collect Unios for food, by fastening bushes to the rear of the raft, so that when they pass through the mussel shoals, where the rivers are shallow, the bushes touch, the Unios close on the leaves and thin branches, holding them securely; and at intervals the bushes are taken out and the Unios removed.

In regard to these pearl excitements which appear from time to time, and as to where best to search for pearls, it may be well to state that it is advisable to search every

creek and river where limestone is the country rock, since in nearly all instances the Unios secrete pearls when this favorable condition exists.

The great quantities of Unio pearls that existed in prehistoric times is evidenced by the Little Miami Valley, explored by Prof. Frederick W. Putnam and Dr. Charles L. Metz, and more recently by Warren K. Moorehead, who carried on operations for Prof. Putnam. The former procured over 60,000 pearls, nearly two bushels, drilled, undoubtedly of Unio origin, all of them, however, decayed or much altered, and of no commercial value. In 1884, the former scientists examined the Marriott Mound, where they found nearly 100 Unio shells, and among other objects of special interest six canine teeth of bears, that were perforated by a lateral hole near the edge at the point of the greatest curvature of the root, and by passing a cord through this, the tooth could be fastened to any object or worn as an ornament. Two of these teeth had a hole bored through near the end of the root on the side opposite the lateral perforation, and the whole countersunk in order to receive a large spherical pearl, about $\frac{3}{8}$ inch in diameter. When the teeth were found, the pearls were in place, although chalky from decay. Upward of 250 pearl beads were found, concerning which they say: "The pearl beads found in the several positions mentioned are natural pearl, probably obtained from the several species of Unios in the Ohio River. In size they vary from $_{10}$ inch to $\frac{1}{2}$ inch in diameter, and many are spherical. They are neatly drilled, and the larger from opposite sides. These pearls are now chalky and crumble on handling, but when fresh they would have formed brilliant necklaces and pendants." The find of Mr. Moorehead is exhibited in the Anthropology Building of the World's Fair, and belongs to the collection that is to be made the permanent one of the city of Chicago, to be shown ultimately in the Fine Arts Building, Jackson Park.

Among marine shells of the United States, the common clam (Venus mercenaria) secretes pure white pearls, scarcely distinguishable from ivory buttons, as well as others faintly tinted with a purplish blue, passing at times to a reddish purple, and a purplish black. The white pearls are worthless, the tinted ones are of little value, but those of a darker color are often from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in diameter, and the finest ones bring from $20 to $100. The supply is limited, and there is very little demand, for unless the color is exceptionally good they possess little beauty, lacking the lustre peculiar to other pearls; still, when mounted with diamonds, the appearance of darker ones is much improved.

The making of wampum from these shells and from the conch has been carried on by a family of Campbells at Pascack, New Jersey, from 1770 to the present time. The last four brothers were over 80 years old in 1889. See "Gems and Precious Stones of North America," pages 233 and 234.

The common oysters (Ostrea borealis and Ostrea virginica) occasionally secrete one or more pearly bodies, always dead-white in color. The reflections produced by their fibrous, radiated structure are similar to those observed in the common conch. The "skin" of these pearls is never smooth or lustrous, and consequently they have no value.

Conch pearls—the concretions found in the common conch of the West Indies (Strombus gigas)—are not nacreous, and therefore cannot be considered true pearls. They are usually a little elongated or oblong in form, rarely round, and most of them are very beautiful, owing to the reflections produced by their fibrous, stellated structure, causing the light to play over the surface, but giving a different effect from the cat's eye, or that of satin-spar. They are almost pink in color, and the fine ones are wonderfully lustrous.

The abalone (haliotis, or ear-shell), the principal species

of which are Haliotis splendens and Haliotis rufescens (called ormer in the Channel Island, fuh-yu in China, awabi in Japan, and abalone in California), also secretes pearls. The nacreous portion of the shell itself is used for ornamental purposes, such as buttons, etc., and surface ornamentation in lacquer work, papier-mache, etc. The mollusk itself, called "mutton-fish" by the New Zealanders, has long been known to the Indians of the Pacific coast as a valuable article of food, and it is much sought after by the Japanese and Chinese for the same purpose. The former take only the very smallest fish, and eat them when freshly caught, with cayenne pepper and vinegar, while the Chinese seek out the largest, and eat them only after they have been dried.

The trade in this dried meat is considerable. In 1866 there were exported from San Francisco by steamer 1,697 sacks, valued at $14,440, and in 1867 the exports had risen to 3,713 sacks, valued at $33,090. At present there are exported upward of 200 tons a year, which at $175 a ton would amount to $35,000. At San Diego, Cal., the dried meat is quoted at $110 a ton. The shells vary from almost microscopic size to eight or ten inches in diameter. Before they were found to have marketable value, they were thrown away. One heap a little south of San Diego, containing over a hundred tons of shells, from exposure to the rain and the sun, was converted into lime on the outside; but this was broken into and many fine shells were found. The Pueblo, Zuni and Navajo Indians, and all the Indians of the Pacific coast as far north as Alaska, have made the abalone shell into charms and have used it for ornamentation with remarkable taste, for ages. It was used with great success by Messrs. Tiffany & Co., as an applied decoration on silver objects, and was exhibited at the World's Fair held in Paris during 1889.

The collector of customs at San Francisco furnishes the information that for the fiscal year 1887–1888, the export of

abalone shell amounted to $185,414, which, together with $35,000, the value of the dried meat annually exported, makes this quite an important industry. These shells secrete very curious pearly masses, sometimes of fine lustre and choice enough to deserve a place among pearls. A pearl measuring two inches in length and from ¼ to ½ inch in width has been found. A necklace made in California from the finest specimens was valued at $2.000. A pearl over half an inch long and of good color cost $30, and was used as the body of a jeweled fly. The abalone pearls from the coasts of Korea and Japan are often very beautiful. In a lot of about one hundred shells only five were found bearing pearls, two with three pearls each, two with two pearls each, and one with a single pearl.

Capt. J. W. Collins—I have been very much interested in the valuable paper read by Mr. Kunz. It is timely and important, and is worthy of careful consideration by those of our citizens living in the interior who are interested in the collection of fresh water-pearls. As most of you know, many pearls have been gathered in the Central States, and especially in some of the States bordering the Great Lakes. I fear, however, that lack of information on the part of those who have been engaged in this effort has resulted in the practical extermination of pearl-bearing shells in certain regions, since I believe it to be true that, practically in all cases, the animals have been killed in order to ascertain whether they contained pearls or not. If the people who sought the pearls had known that it was perfectly feasible to obtain them without injuring the animals, by the use of a simple tool, such as has been mentioned by Mr. Kunz, and had they realized the importance to them in future years of conserving the supply of these wealth-producing bivalves, there is reason to believe that quite a large collection of pearls could have been made at intervals of every few years. Now, however, because of a lack of this knowledge, the pearl producing shells in the sections

referred to, are practically annihilated, and it will probably be many years before it is possible to reap another harvest. I know of nothing which bears upon the fisheries of our interior States, which could be of more service to those interested in this industry, than the widespread publication of the paper that Mr. Kunz has favored us with. Whatever tends to improve the knowledge of our fishermen, and enables them to conserve the supply of those animals which constitute objects of fishery, while seeking aquatic wealth, adds materially to the welfare and prosperity of our country and the comfort of our people.

Among the fishery subjects that demand the intelligent consideration of State legislators, none, perhaps, should receive more prompt attention than this matter of gathering pearls. No State can afford to neglect legislation on a subject so important. Unless there is legislative restriction, we may look for a repetition of what has been done in the States referred to by Mr. Kunz.

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## THE SUNAPEE SAIBLING: A FOURTH NEW ENGLAND VARIETY OF SALVELINUS.

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The sudden and unaccountable appearance, in large numbers, of a valuable food and game fish in any of our inland waters would be hailed as a most important event both in the angling and the ichthyological world. Assume that fish to be a prolific and rapidly growing salmonoid, surpassing all congeners in symmetry and brilliancy of coloration, equalling the most delicate in table merits, and excelled in game qualities by the land-locked salmon alone—and you may readily comprehend the enthusiasm which, some seven or eight years ago, greeted the discov-

ery of a New Hampshire charr characterized by such a synthesis of traits.

Until the year 1885 but three species of trout, or, more properly, *charr* (a Gaelic word meaning *red*, or *blood-colored*), were recognized as native to New England, viz.:

I. The *Salvelinus fontinalis*, or common brook trout.

II. The *Salvelinus namaycush*, the longe, togue, lake, or Mackinaw trout.

III. The *Salvelinus stagnalis* of Fabricius; *oquassa* of Girard and Gunther, the diminutive blue-back of the Rangeley Lakes of western Maine—the last closely allied to species widely spread through Arctic America, as well as to the European saibling.

From this classification is omitted *Salmo agassizii*, of Lake Monadnock, N. H., now recognized as a variety of brook trout; and the *Salmo hucho*, or *hunchen* trout, mentioned by Dr. Smith in his "Natural History of the Fishes of Massachusetts," 1833, and therein claimed to be related to the true *hucho* of the Danube. Its forked tail, dusky hue and reddish spots, coupled with the statement that it was brought to market in a frozen condition from lakes in New Hampshire and Maine, make it probable that the Massachusetts *hucho* was merely a variety of *namaycush*.

Even Prof. Jordan, in an article on the Salmon Family, published in "Science Sketches" as late as 1888, is silent as regards a fourth New England species; although Prof. Garman, of the Museum of Comparative Zoology at Cambridge, in his paper on the American Salmon and Trout (1885), calls attention, under the head of *Salmo fontinalis*, to a form, Fig. 16, of which he says: "A knowledge of the younger stages of this fish from the same locality may lead to a separation of the form." Subsequent research *has* led to such a separation, and ichthyologists now admit the presence of a fourth variety of *Salvelinus* in New England —the *alpinus aureolus*, or golden-hued Alpine charr,

whose life history and general characteristics it is the purpose of this paper to present.

As far as is known, the first specimens of this new fish to be distinguished from the well-known forms were taken in Sunapee Lake, Merrimac Co., New Hampshire, during the summer of 1881, by Lieut. Ransom F. Sargent and Mr. Alonzo J. Cheney, respectively of New London and Wilmot, experienced anglers, who immediately recognized in the three individuals captured by them specimens of a salmonoid distinct from the *namaycush* and from the brook trout of the region. The fish taken weighed from two to three pounds each, and were known by the name of "St. John's River trout," because they were believed to be descendants of fry planted in the lake in 1867 by the first Fish Commissioners of the State, and supposed by the resident population to have come from the St. John River, N. B. The conspicuous development of the under jaw in the males led to the local names of "hawkbill" and "hookbill;" the silvery sides of the fish in summer gave rise to that of "white trout." In the two following years, 1882 and 1883, a sufficient number of the deep-swimming stranger was taken to excite comment and conjecture on the part of outsiders who had heard of its presence in Sunapee Lake; and in 1884, Col. Elliott B. Hodge, of Holderness, the New Hampshire Fish and Game Commissioner, finding confirmation in the reports that reached him for a view he seems long to have privately held, ventured the opinion that many Canadian and northern New England lakes contained a large charr, whose habit of retiring to the deepest and coldest waters throughout the summer, and of approaching the surface for a few days only at the end of October, explained a general ignorance concerning its very existence. Col. Hodge's theory received apparent substantiation from his accidental discovery in October, 1885, of vast numbers of a mysterious charr spawning on a mid-lake, rocky shoal at Sunapee. He wrote at the

time: "I can show you an acre of these trout, hundreds of which will weigh from three to eight pounds each. I could never have believed such a sight possible in New Hampshire. The new fish differs from the brook trout in many ways. The females have a brownish back and lemon-colored sides; the males, a bluish black back and golden-orange sides. The fins are much larger than in the brook trout, and there is an entire absence of the mottling characteristic of the latter fish."

Thus Col. Hodge recognized in this graceful, high-colored charr a new variety, and he lost no time in inviting the attention of scientists to the New Hampshire beauty. Specimens were forwarded to the Museum of Comparative Zoology at Cambridge, Mass., and to Dr. Tarleton H. Bean, Curator of the Department of Fishes, National Museum, only to be pronounced at both centres varieties of brook trout. Col. Hodge resented this classification, and sent Dr. Bean other large specimens of the new fish, together with several Sunapee brook trout, urging a more minute examination. Dr. Bean compared the two forms with special care, changed his opinion, frankly admitted that Col. Hodge was right, and pronounced the Sunapee trout "a *Salvelinus* of the *oquassa* type, but of so enormous a size that at first he did not suspect its relation to that species." The late Prof. Baird inclined to the opinion that it might be a representative of a highly variable Arctic charr found in the Dominion of Canada and Greenland, viz.: the *Salvelinus arcturus*. (Victoria Lake and Floeberg Beach in extreme northern part of Arctic America—allied to *stagnalis*.)

A controversy at once arose regarding the origin of this unique trout. Whatever its species, it was a newcomer in the opinion of some; in that of others, a native—the oldest of our charrs, representing the ancestral type, and now almost extinct. Those who took the first view were chiefly

residents of the immediate region. Such unhesitatingly declared that they had never met with the new fish prior to 1883 or 1884. They regarded the *oquassa* (or "Quashy," as it began to be called) either as a descendant of some of the salmonoids introduced into Sunapee in 1867 and succeeding years by the Fish Commissioners, or as a cross between one of these forms and the native brook trout. In no other way could they account for its sudden appearance in large and steadily increasing numbers.

A theory of descent from blue-backs imported from Maine in 1879 by Commissioners Webber and Powers as a food supply for the larger *Salmonidæ*, was soon set aside on the ground that the little trout of the Rangeleys rarely exceeds $\frac{1}{4}$ pound in weight, and could not possibly, even if supplied with an abundance of appropriate food and exposed to the tonic effects of a favorable change of waters, ever attain the aldermanic proportions of the Sunapee charr. Moreover, Dr. Bean, in a scholarly paper published in the *American Angler* and the *Forest and Stream*, February, 1888, called attention to six essential points of difference between the Sunapee trout and the blue-back, thus effectually disposing of the argument.

The theory of natural hybridism found few supporters among ichthyologists, and no introduction of charr other than the Rangeley *Salvelinus fontinalis* and *Salvelinus oquassa* could be proved, as none had been officially reported. From the first, Col. Hodge, believing in the existence of a similar charr in the Province of Quebec, championed the theory of aboriginality, ingeniously combating every objection made to it:

I. That so conspicuous a food fish could not for 100 years have escaped the notice of anglers, poachers and scientists alike—by showing how the habits of the white trout protected it from observation and persecution, it being rarely seen except late in October on mid-lake reefs, that is, *at a time* of year when angling was out of season,

and *in localities* dangerous or impossible of access in the old-style, unseaworthy flat-bottoms during the autumnal windstorms. The secluded habits of the European charrs explain in like manner the obscurity which has so long involved the life history of those fishes. Col. Hodge further claims that ordinary fishermen knew no difference between the white and the brook trout, a thing not to be wondered at when such authorities as Garman and Bean failed at first to separate the forms.

II. The more serious objection that no cause can be shown why the white trout, if a native, should *suddenly* increase in the lake, so as to attract the attention of hundreds of observers, and be taken literally by the ton, Commissioner Hodge meets with the following clever theory: Before the introduction of black bass about 25 years ago, yellow perch swarmed in the lake, and there being then no smelt food, subsisted largely on the eggs and fry of the lake-spawning charr. At the spring hatching time, these perch held carnival among the helpless alevins, almost effecting, by their periodic ravages, the extermination of the white trout. But as the black bass increased in number, they fell upon the perch in turn, until the lake was virtually rid of this voracious pest. Thus the trout, which had been reduced to the verge of annihilation, had a chance to increase. The black bass did not interfere with it for two reasons:

I. Both bass and trout have an abundance of easily caught and tasteful food in the land-locked smelts, which have multiplied since their introduction, until now they literally school in millions.

II. Bass and trout are not found in the same sections of water at the same time, the trout keeping in a temperature of 42° to 45° (on the surface in May, 60 ft. below in July and August); the bass preferring 65° to 70° in summer, and hibernating in winter and during the spring hatching time of the trout. Thus freed from persecution, the saib-

ling has increased, until it is now present in myriads. This is the most ingenious of all the explanations that have been advanced. It is based on facts throughout, and is difficult of overthrow, especially when coupled with a theory of the writer's—that after the introduction of smelts, about 20 years ago, the saibling, if native, learned so far to change their habits as to rise from the depths and follow this food fish to the shores during May and June, thus increasing the chances of discovery. Wherever the smelt schools, there the saibling will be found. An axiom of the Sunapee fisherman is: "Hold the smelts and you will hold the trout," so the smelts are baited in certain localities during the fishing season.

This theory of Col. Hodge encounters but a single objection, viz., if the perch and saibling have been fellows in the Sunapee basin since its excavation during the Glacial Epoch, why was not the process of extermination completed centuries ago? It *must* have been in the case of other lakes on the same primeval watershed, unless we are prepared to admit that an anadromous fish became landlocked in one inland lake alone, while avoiding other bodies of water much more accessible and equally compatible Geology proves that Sunapee once discharged its waters through Newbury summit, and thus was tributary to the Merrimac. Hence, it is fair to assume that when these trout migrated, following like man and the larger mammalia, but through watery channels, the retreating ice-fields and glaciers, they swarmed into many lake-basins, where they became extinct before the advent of the white man. Were perch the instruments of extermination? If so, why did they not put in as thorough work at Sunapee?

It is but right to state at this point that the history of the charr in some European lakes is the history of a fish that has disappeared within the memory of man. This is notably the case at Loch Leven, once the home of a charr

that rivalled the magnificent fish of Windermere. The trout (*fario*) seems the fitter to survive.

While the discussion just outlined was progressing, charr identical with the Sunapee Lake form were sent from Dan Hole Pond, Carroll Co., N. H., and from Flood's Pond, in the town of Otis, 16 miles from Ellsworth, Maine, to Prof. Garman and Dr. Bean. The water of both these lakes is deep, clear and cold, as in the case of Sunapee. Dan Hole Pond, at the headwaters of the Ossipee River, is tributary to the Saco. Flood's Pond connects with the Union River, which enters Blue Hill Bay near Mt. Desert. Thus the new *Salvelinus* is represented in three distinct drainage basins in New England.

In company with Col. Hodge I visited Dan Hole Pond in the summer of 1889, but failed to secure a specimen of the saibling. In the fall of 1890, however, several specimens were sent from the pond to Cambridge and to Washington, where they were pronounced identical with the Sunapee form. Old residents declared them identical also with trout which had for fifty years been speared on the same spawning bed. The present representative from Ossipee informs me, through Commissioner Hodge, that he has seen many individuals of this species weighing 10 and 12 pounds—all this years before a German saibling egg was imported.

I am indebted to Dr. Walter M. Haines, of Ellsworth, Maine, for the following facts regarding Flood's Pond: The pond is three miles long and ¾ mile wide. It is surrounded by high, well-wooded land, and is 100 feet deep, the bottom being pure white sand or gravel. There are the usual inlets and spring-holes. The outlet is a stream of considerable size, and has been dammed in many places for the last forty years. The Flood's Pond saibling, declared by Prof. Garman to correspond exactly with the Sunapee fish, is known in the neighborhood as the "silver," or "white trout," to distinguish it from "the square-

tail," or brook trout, and "the togue," or lake trout. It attains a weight of five or six pounds. Two hundred pounds have been taken by a single angler in a day, but it is never caught except in one particular locality. It spawns in the lake on a fine gravel beach, in three feet of water, and does not enter the inlets. Nothing but smelts are ever found in its stomach. Flood's Pond contains neither perch nor bass.

Since, then, by reason of dams on the outlets, no fishes of marine ancestry could, within the last fifty years, have gained access either to Dan Hole or Flood's Pond without artificial help—since land-locked salmon only have been planted in these ponds, and that quite recently—and since there seems to be trustworthy evidence of the existence of this so-called silver trout in each body of water for at least half a century—it is fair to conclude that the *Salvelinus alpinus aureolus* is a native of two Maine drainage basins, and therefore is aboriginal to New England, an American representative of the European saibling, red charr, or *ombre chevalier*.

But this does not prove its aboriginality to Sunapee Lake, N. H., although, all circumstances considered, it renders such aboriginality highly probable, inasmuch as no data exist to establish a plant of this variety at any time in Sunapee Lake, and no German saibling eggs were brought to New Hampshire before January, 1881. The fact that the fry from the eggs sent to Plymouth in that year were placed in Newfound Lake, a body of water apparently in every way adapted to the nature of the saibling, but have never been heard from, is further significant here. It may prove that the foreign fish cannot find the necessary conditions in the New Hampshire lakes. The failure of the farmers at Sunapee to distinguish between the large brook trout and the saibling (if the latter fish was a native) is in contrast with the positive knowledge of a difference at Dan Hole and Flood's Ponds. Its explana-

tion may be sought in the habits of the Sunapee saibling, as already described, or in the ignorance of the few who in old times may ever have seen it, and who cared for nothing beyond the fact that it was good to eat.

Ford's Pond in Warren, and Silver Lake in Madison, are associated with traditions of the fall spearing on their spawning beds of large, high-colored trout, which are believed, from reports as to their habits and appearance, to have belonged to this same species. These two ponds, then, may represent a traditional habitat. The waters of Silver Lake find their way into the Saco; I was unable to learn whether Ford's Pond discharges into the Connecticut, or through Baker's River into the Merrimac.

In April, 1893, a four-pound specimen of a square-tailed trout was sent to me from Swan Lake, near Belfast, Maine. It was remarkably like the *aureolus* of Sunapee, from which fish it differed in having a large mouth, well-armed with teeth, and a mottled dorsal fin. The pectoral, ventral and anal fins were orange in hue, but smaller than in the case of the Sunapee species. Prof. Garman inclined to the opinion that the Swan Lake fish (judging from this one specimen) is a form of *Salvelinus fontinalis*. Were hybridism possible, I should suspect a cross between the brook trout and the American saibling. At first sight one would certainly pronounce the Swan Lake fish an *aureolus*.

Swan Lake is but a short distance from Flood's Pond, the valley of the Penobscot lying between the two.

I am under obligations to Dr. Bashford Dean, of the Department of Biology, Columbia College, for material assistance in determining the following anatomical description of the Sunapee saibling:

Two specimens of one pound and three pounds respectively were carefully examined.

### FIN RAY FORMULA.

| | 1-LB. SPECIMEN. | 3-LB. SPECIMEN. |
|---|---|---|
| Pectoral | 14 | 13 |
| Dorsal | 13 | 14 |
| Ventral | 11 | 10 |
| Anal | 13 | 12 |
| Caudal | 26 | 28 |

(including rudimentaries.)

### SQUAMATION.

| | 1-LB. SPECIMEN. | 3-LB. SPECIMEN. |
|---|---|---|
| Lateral | 211 to 212 | 226 |
| To lateral line | 38 | 41 |
| To vent | 62 | 63 |

### DENTITION.

(Feebly developed as in the Irish charrs.)

| | 1-LB. SPECIMEN. | 3-LB. SPECIMEN. |
|---|---|---|
| *Maxillary* (superior and inf.) | 13 and 14 | 16 |
| *Pre* or *Intermaxillary* | 4 and 5 | 4 and 3 |
| *Vomerine* (very small) | 6 in number | 2 and larger |
| *Palatines* (right and left) | 12 and 13 | 13 and 13 |
| *Glossal* two rows of | 4 | 5 and 4. |

### GILL RAKERS.

18 in front row. 18 in second row.

Slender and longer than in the brook trout.

### PYLORIC CŒCA.

1-LB. SPECIMEN, 45 (small and short) 3-LB. SPECIMEN, 52

### BRANCHIOSTEGALS.

9 on each side.

In young specimens, the gill cover overlaps the root of the pectoral; not in adults. There are spots on the dorsal fin, and attention should be called to a post-ventral dermal appendage.

Such differences in individuals from the same locality would seem to impair the value of anatomical peculiarities as diagnostic marks. In fact, in a most able paper on the Saiblings, published in the *American Angler*, February 7, 1891, and *Shooting and Fishing*, February 12, Prof. Garman states that in foreign specimens examined by him the dentition differs, corresponding more or less nearly with that of the New Hampshire fish—that differences of age imply radical differences in teeth, fins, stomach, and especially gill-rakers—which latter Prof. Garman believes

to be "most important in function early in life and to deteriorate with change to coarser food." The deterioration consists in a distortion not alike in any two individuals; "the rakers curve and twist in every direction like a lot of writhing worms suddenly become rigid." In old specimens they lose their points and grow club-shaped. As to the number of gill-rakers, in saibling where Dr. Bean found 10 and Prof. Jordan 14 to 15, Prof. Garman counted 14 to 18. And in the New Hampshire charr, where the first found 14. and the second 11 to 12, Prof. Garman counted 13 to 16. In our specimens, 18 were counted in each row.

The external characteristics of the Sunapee fish, however, distinguish it conspicuously from the three other charrs of New England. Its graceful build, small and delicately shaped head, small mouth, excessively developed fins, more or less markedly emarginate caudal, spots without the blue areola, and unmottled back, at once separate it from the brook trout, and link it as closely as its structural peculiarities with Austrian, British and Swiss congeners. The nuptial coloration is gorgeous beyond example among our indigenous *Salmonidæ*. Throughout the spring and summer the back is dark sea-green, blending on the sides into a flashing silver, which in turn deepens below into a rich cream. But as the October pairing time approaches, the fish is metamorphosed into a creature of indescribable brilliancy. The deep purplish blue of the back and shoulders now seems to dissolve into a dreamy sheen of amethyst, through which the inconspicuous pale lemon spots of midsummer flame out in points of yellow or vermilion fire; while below the lateral line all is dazzling orange. The fins catch the hue of the adjacent parts, and pectoral, ventral, anal and lower lobe of caudal, are ribboned with a broad white margin. As in the case of the Windermere charr, these white margins of the fins are very conspicuous in specimens seen swimming in the

water. There are great differences in intensity of general coloration, and the females are not usually as gaudily tinted as the males. The intermediate types and different depths of hue observable in an autumn school recall the public promenade in a West Indian city, where all shades of transition are found, from pure white to tawny black. Those who have seen the flashing hordes on the spawning beds, in all their glory of color and majesty of action, pronounce it a spectacle never to be forgotten.

Sunapee saibling kept in confinement entirely lose the sexual instinct, and with it the wedding garment. So sensitive are the females that their removal from the spawning beds to the State Hatchery on the opposite shore of the lake, only one mile distant, seriously interferes with the maturing process, so that it is almost impossible to secure eggs, the fish having frequently to be returned to the water several times during the operation. Hence, as far as possible, ripe specimens are selected on the natural spawning beds, and there stripped rapidly and returned to the lake. Instances are not exceptional in which females refuse to part with their eggs and carry them over to the next season. This tallies with Mr. Cholmondeley-Pennell's suggestion that some of the Windermere charr spawn in alternate years.

Although a vigorous fighter, the white trout is very easily injured, the prick of the hook often being followed by fatal consequences, especially in young specimens. Hundreds are thus unavoidably killed every summer. In this respect the Sunapee charr is very unlike the blueback of Maine, of which Commissioner Stanley said: "They are a hardy fish, and nearly as tenacious of life as the eel or bullhead. I have frequently seen them alive in the morning after lying all night on the shore."

One other phase of *aureolus* life is a marked tendency to deformity. Remarkable differences in shape, as well as coloration, are normal to the quadroons and octoroons of

the Sunapee spawning beds; but these differences are sometimes carried to the verge of distortion or even monstrosity. Humped backs are not infrequent; but the most repulsive and at the same time most common malformation is the shrinking of the mature fish into an eel-like shape, with abdominal respiration and an intensely reproachful human look in the cavernous eyes, which fix your gaze with a mysterious intelligence. The death scene of such a fish will haunt one for days, tempting him to speculation in the field of metempsychosis.

Prof. Garman has proclaimed his belief in the identity of the Sunapee, Dan Hole and Flood's Pond charrs with the European saibling, and that "the affinities of these forms are closer to that saibling by way of an Atlantic steamer than by way of Greenland and Iceland."

Prof. Jordan has said "the American charr is probably not a distinct species, but native to the waters where it is now found, and not an importation from Europe." "Should it appear," he continues, "that the saibling in that part of Germany from which specimens have been brought to America, have gill-rakers like those of the Sunapee trout, this opinion would be reconsidered." Prof. Garman has disposed of the gill-raker argument, but as far as I know Prof. Jordan has not further expressed himself in regard to the Sunapee form; although in a recent article on the salmon and trout of the Pacific coast he states that "in the lakes of Greenland and the eastern part of British America the European charr is as abundant as it is in Europe—a fact which has only lately been made manifest."

Mr. J. G. A. Creighton, of Ottawa, Canada, writes under date of February 16, 1893: "From the height and character of Sunapee Lake, it is not at all improbable that an Arctic variety may have survived there which has perished, or been transformed, elsewhere south of 55° or 60° N. Lat. Arctic species must have been common to all our waters in the Glacial period."

The opinion of Prof. Jordan and Mr. Creighton regarding the survival of Arctic charr in southern Canada and northeastern United States have received confirmation recently by the discovery, in a lake of Huntertown, Province of Quebec, of a symmetrical, unmottled, unspotted charr, with markedly forked tail, small fins, diminutive mouth, weak dentition, large liquid eye, pink flush and brilliant iridescence below the median line. I can say of the specimen examined by me that it was *neither a blue-back nor a Sunapee saibling.*

Prof. Garman writes me under date of November 17, 1892, that "no good evidence has been advanced of the existence of this species *on this continent* previous to 1884." It is a matter of record, however, that 60,000 German saibling eggs, the gift of the Deutsche Fischerei Verein, were sent to New Hampshire in January, 1881. It is further to be taken into consideration that the writer of this paper had in his possession, at Sunapee Lake, in the summer of 1882, a four-pound specimen of the saibling in question—which could not have developed from fry hatched the preceding year! No saibling have ever been sent to Maine by the United States Fish Commission; and, as has been shown, it is impossible that the fish in Flood's Pond can be descendants of the New Hampshire charr. The theory that there was nothing to prevent the *Salvelinus alpinus* of Sunapee Lake in recent years from descending the Connecticut River to Long Island Sound, and thence making its way into streams and connecting lakes from the shores of Connecticut to those of Greenland, may be disposed of in a single word—*Dams.*

The Sunapee charr is undoubtedly a representative of the European form; but reasons have been given why it is believed to be a native of this continent. It differs no more extensively from the several European varieties than they do among themselves. Von dem Borne, Profs. Benecke and Dalmer, Wittmack, of Berlin—all speak of

important differences in form, size and color, according to age, sex, season and habitat. All authorities allude to the *solid* sea-green or dark blue of the back, the yellowish sides and the red or orange belly. Benecke and Dalmer refer picturesquely to the half-moon tail. As to spots, there is endless variety. Some forms have none; some, large spots; others, small—yellow, orange and red—and singularly, in certain species, each spot is surrounded by a white ring or halo. The fins take their color from the back and sides, and have the broad white band. The foreign saibling is gregarious, like the Sunapee form; lives similarly on crustaceans, worms and fish food, and seeks the deepest and coldest waters. The greater the altitude, the more intense the coloration and the smaller the fish. In Lake Zug the saibling run eight or nine to the pound; in Lake Geneva they are said to attain a weight of over 20 pounds. The flesh is white or red, which, however, makes no difference in the flavor. The foreign saibling is taken in nets, or with hook and line; it is eaten fresh or smoked.

Col. Hodge has attempted to prove a dissimilarity between the German saibling and the Sunapee charr by crossing each with our common brook trout, and noticing differences in the markings of the resulting fry. He writes me that the eggs of the cross between the German saibling and our brook trout are larger than those of the cross between the Sunapee *aureolus* and the brook trout, and that there are conspicuous differences in the fry of the two hybrids, both of which are fertile. Crossing our brook trout with other forms of the foreign saibling would certainly give different results again; so the experiments of Col. Hodge cannot be regarded as conclusive beyond establishing the fact *that the aureolus of Sunapee is in no way connected with the particular form of German saibling sent to New Hampshire in* 1881*;* but this is a most important fact in the induction of its aboriginality to New

England. Col. Hodge further states another supposed difference: "The *aureolus* does not seek the streams to spawn; the saibling does." But the saibling does not always spawn in streams; the rule is the other way. At Windermere, the charr spawn both on the rocky bed of the Brathay and in the lake. Schroeder, in his "Katechismus der Kuenstlichen Fischzucht," expressly states that the saibling in October and November ascends from the depths in which it usually lives, and spawns off sandy shores in the lakes. Profs. Benecke and Dalmer describe great schools of fish spawning in October or later, even as late as January and March, on sand or gravel near the shores. The Sunapee fish, then, simply follows the practice of its European relatives.

Finally, there can be no doubt as to the economic value of this new fish. It is one of the most prolific of our salmonoids, the female averaging 1,200 eggs to the pound, or 200 more than the brook trout. It is also a singularly rapid grower where smelt food abounds. The extreme weight known to have been attained in Sunapee is about eight pounds, although accounts exist of much larger fish in this water, and of specimens from Dan Hole and Flood's Ponds weighing from 15 to 20 pounds.

The Sunapee saibling takes live bait readily, and affords the angler superb sport if the tackle be light. With a seven-ounce rod and 200 feet of line, the killing of a five-pounder from a sail-boat running across the wind, implies a delightful excitement that, to be appreciated, must be experienced. Three tons of this fish have been taken with hook and line in a single season at Sunapee. The flesh is of a light salmon color, and when in its perfection excels in delicacy that of all other *Salmonidæ*.

We must confidently recommend this charr to the attention of State Commissioners interested in placing a valuable and easily propagated food fish within reach of the people. It is *facile princeps*, from its rush at the cast

smelt to the finish at the breakfast table. Those who best know it most enthusiastically indorse, with a slight amendment, Prof. Jordan's apothegm: "Nothing higher can be said of a salmonoid than that it is a [Sunapee] charr."

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## ON THE HANDLING OF ADHESIVE EGGS.

BY PROF. JACOB REIGHARD.

The title of the paper which I will read at this time is upon the handling of adhesive eggs. A part of what I have to say has already been printed in the Tenth Annual Report of the Michigan Fish Commission, with some additions.

Those who have had experience in taking the eggs of the wall-eyed pike or pike-perch are familiar with the difficulties which arise from their adhesiveness. For the first hour or two after they are placed in the water the eggs adhere to one another and to the vessel which contains them. The adhesiveness is due to the action of the water on the outer egg membrane, which behaves in this respect like other mucous bodies.

It has been thought necessary to resort to constant stirring or shaking in order to keep the eggs apart. Not only is much time wasted in this stirring or shaking, but large numbers of the eggs are injured. Even after the eggs have been placed in the hatching jars, dead ones are attacked by fungus, which causes them to adhere to one another and to the living eggs, so that they must frequently be taken from the jars and passed through sieves in order to separate them.

These eggs are usually delicate, and the result of this rough handling to which they are subjected, owing to mechanical injuries and the resulting attacks of fungus, is that about 70% of them are usually killed. It seemed, therefore, desirable to find some method of dealing with

these eggs which should prevent their adhering to one another, without its being necessary to resort to stirring or other mechanical agitation.

One method that has been pursued is to allow the eggs to lie in the water in which they are fertilized. Such water is milky from the large number of spermatozoa which it contains, and is also quite strongly alkaline.

Eggs left in the water do not adhere, and after having lain in the milted water for two hours they may be transferred to fresh water, and will usually not then adhere. This would then seem to be a solution of the difficulty, but some experiments which I have made, and which are published in the Tenth Report of the Michigan Fish Commission, show that when eggs are treated in this way many of them fail to absorb water and remain of smaller size and softer than normal eggs. Such eggs do not afterward develop. The method is, therefore, not practicable.

It seemed that the result sought might be accomplished in any one of three other ways.

1. Some substance might be dissolved in the water, which, without injuring the egg or spermatozoon, might still so act on the external egg membrane as to destroy its adhesive properties. It is known that the spermatozoa live in weak solutions of various substances and that eggs are not readily killed by many such solutions. A considerable number of such substances was tried in very weak solution. Among them were common salt, chromic acid, chromic acid combined with salt, ammonium hydrate, potassium hydrate, sodium carbonate, sodium sulphate and egg albumen. But the experiments were fruitless, and it is not necessary to detail them here. A mixture of salt and chromic acid destroys the adhesion of the eggs permanently, but the spermatozoa do not live well in it, and the egg does not fill after its action.

2. It might answer to allow eggs to adhere to one another in a mass and afterwards to separate them by me-

chanical means, such as passing them through a sieve. This method has been pursued, as I learn from Mr. Stranahan, at the United States hatchery at Put-in-Bay, Ohio.

A trial showed that the eggs when separated are distorted by the mutual pressure. Some are elongated, others are flattened, and scarcely any are spherical. About 10 to 15 per cent. more of the eggs are injured mechanically than by the process next to be described.

3. It might be possible to add to the water some substance that should get between the eggs and prevent their touching one another. It was believed that the reason that the eggs did not adhere in milted water is that the heads of the spermatozoa attach themselves to the surfaces of the eggs, and thus so thickly studded with these little bodies that they cannot touch one another, and do not therefore adhere.

The alkalinity of the milt prevents the eggs from filling, and it was thought that perhaps some other finely divided substance not alkaline might be placed in the water to take the place of the milt. Trials were made of egg yolk. After fertilizing the eggs they were placed in water containing egg yolk in a finely divided condition. The eggs did not adhere, but they did not develop. Fine clay mixed with water was also found to be useless. The egg yolk probably failed through some chemical action on the eggs or milt. It seemed likely that the failure of the clay was to be attributed to the fact that the fine hard particles cut their way into the outer egg membrane and became so deeply imbedded in it that the eggs were able to touch one another and adhere.

Corn starch was then tried. About one volume of dry corn starch was added to 20 volumes of water. The eggs were fertilized in the usual way, and were immediately, after two or three minutes, poured into the starch water. Another lot of eggs was then fertilized and added to the starch water, and the work was continued until the pail

containing the starch water had been half filled. It was found that the eggs settled to the bottom of the pail and became thickly coated with the starch, which prevented their adhering to one another. The eggs could thus lie quietly, and the evil effects of the agitation were avoided. At the same time, by being placed in the starch water they were brought suddenly into a large quantity of fresh water, and the milt was thus washed off almost immediately, so that the water on the eggs was not alkaline. The starch in the pails settles slowly, so that after ten minutes there is much starch in the water at the bottom of the pail and but little in that at the top. The top water may then be poured off and fresh water added, and the egg and starch brought into contact with the fresh water by a few twisting and swinging movements of the pail. As the starch again settles, the water may be again changed, so that without using fresh starch there is a changing of the water every ten minutes, if deemed necessary. The eggs may lie in the starch water for four hours or longer, but at the end of two hours they were usually washed up to free them from starch. They were found well filled and developing normally; they had not adhered to one another and did not adhere when transferred to fresh water The starch appears to have no other effect on the eggs than to keep them apart.

Counts of eggs treated in this way showed between 15 and 30 per cent. more of fertilized eggs than were obtained by the usual method.

Here are two examples taken from a considerable number of experiments. In each case a batch of eggs was fertilized and then divided into two lots; one lot was then treated in the usual way, while the other was treated by the starch method:

TRIAL ONE.

| BY THE USUAL METHOD. | | | BY USE OF STARCH. | |
|---|---|---|---|---|
| Segmenting | 112 | 63% | 153 | 99% |
| Injured | 2 | 1% | 2 | 1% |
| Not segmenting | 63 | 36% | 0 | 0% |
| Total | 177 | 100% | 155 | 100% |

TRIAL TWO.

| BY USE OF STARCH. | | | BY THE USUAL METHOD. | |
|---|---|---|---|---|
| Segmenting | 81 | 30% | 39 | 15% |
| Injured | 18 | 6% | 33 | 12% |
| Not segmenting | 176 | 64% | 190 | 73% |
| Total | 275 | 100% | 262 | 100% |

The first trial shows a gain of 36 per cent. (almost double the average), and the second a gain of 15 per cent. by the starch method. Three other trials gave each a gain of 15 per cent., and a fourth trial gave a gain of 23 per cent. By the usual method is meant that the eggs were kept in motion and the milt washed off rather slowly. A trial of the method of allowing the eggs to adhere, and afterward separating them, showed a gain of about 5 per cent. over the usual method, but a disadvantage of 10 to 15 per cent. as compared with the starch method.

Thus out of a considerable number of experiments there is an average gain of about 20 per cent. by the use of the starch method ; so that the method certainly merits a trial on a commercial scale. It is always possible to handle a small number of eggs, as a few thousands, in such a way as to secure a very large percentage of fertilized and uninjured eggs. The extreme care in manipulation, which is necessary to accomplish this, cannot be used where the number of eggs is so greatly increased and where the conditions for working are so unfavorable, as is usual in commercial practice. By the use of starch, eggs may be handled with very much less trouble than by the methods now in vogue, so that the method may be of value, even if

it is found in practice to produce no increase in the number of eggs saved.

During the present season Mr. Dwight Lydell, an employee of the Michigan Fish Commission, has kindly made for me some tests of this question, the results of which are as follows:

On May 13 about five and one-half million eggs were taken by the starch method at Roberts Landing, on the St. Clair River: these were shipped by steamer to Detroit and placed in closed jars. On May 24 the good eggs remaining in the jars were measured, and it was found to be 35 per cent. of the number placed in the jars. Eggs not treated by this method showed 30 per cent. of good eggs. The advantage of 5 per cent. thus apparently gained by the use of the starch is so slight as to be scarcely worth consideration.

It then occurred to me that perhaps the agitation due to shipping the eggs, and to the repeated handling in the hatchery in order to remove injured eggs, might be responsible for the loss. The eggs are usually shipped on the day following that on which they are taken. At this time the material which is to form the embryo lies on one side of the yolk in the form of a little disc or cap, the germinal disc. The rest of the yolk is covered by only a very thin layer of protoplasm, which is continuous with the germinal disc at its edge.

This layer of protoplasm is very easily ruptured so that the yolk protrudes through it into the space between the yolk and the shell. The yolk which thus escapes turns white and the egg dies. Early in the history of the egg the germinal disc extends itself over the yolk, and finally completely covers it. The yolk is thus protruded by a firm layer of much greater thickness than the original protoplastic covering. This layer is not easily ruptured, and the egg is consequently less liable to injury by mechanical means.

It takes about four days for the germinal disc to grow over the yolk and enclose it. It was thought that if the eggs could be kept quietly for four days at the point where they were taken, that they would be much more likely to withstand the subsequent transportation and the handling necessitated by running them in jars.

At my suggestion, Mr. Lydell on May 23, fertilized a batch of eggs by the use of starch. Seven pints of the eggs were placed in hatching boxes in the river, and three pints were placed on trays in shipping boxes. At the end of four days both lots were sent to the Detroit hatchery. When about to hatch, the good eggs were measured, and it was found that of those placed in hatching boxes there were three pints, or 43 per cent., while of those kept on trays there were 61 per cent. good. This is an average gain of about 20 per cent. over the average results of the last few years.

A second trial was made as follows: On May 5, 1,050,000 eggs taken with starch were placed in hatching boxes. On May 29 they were shipped to Detroit and put in jars until they hatched on June 2. Six hundred thousand, or 57 per cent. of these eggs were then found to be good.

Finally, it was thought that the advantage thus gained might be increased by holding the eggs in the hatching boxes until they were hatched. The first trial of this sort yielded 56 per cent. of good eggs by the starch method. The following comparative test was then made: On May 9 eight quarts of eggs were taken, four by the use of starch and four in the ordinary way. There was no other difference between the two sets of eggs. After they had filled they were placed in hatching boxes. On May 27 they were about to hatch. About 2,000 eggs were taken at random from each box after stirring the eggs in the box, and counted. The eggs taken were an average sample of the eggs in the box. Those treated without starch showed 50 per cent. of good eggs, while those that had been

handled by the use of starch showed 73 per cent. of good eggs.

It will thus be seen that the use of starch yields a uniform gain of about 20 per cent., provided the eggs are held for four days before shipping. This last experiment shows a still further gain of 20 per cent. when the eggs are not shipped at all, but are allowed to hatch in the boxes. There is no reason known to me why this method should not be pursued, and the eggs carried to hatching boxes until ready to hatch. They could then be transported in order to be planted.

I bring the method forward here in the hope that members of this Association will be led to test it, and I shall be glad to know the result of any such test.

The reading of Prof. Reighard's paper elicited the following discussion:

Mr. F. N. Clark—Mr. President, I have been very much interested in Prof. Reighard's paper. I wish to state in this connection my experience in transporting those eggs after they are well-developed. I have taken some of the pike-perch eggs from Detroit to Chicago, which were parts of lots that were taken by the Michigan Fish Commission on the St. Clair River. The last lot I brought here I delivered to Mr. Ravanel, and they were well-developed eggs, a part of them at least, and a part were not. When I got them here the starched eggs were very good indeed; just what percentage of good eggs there were I don't know, but those that were not starched were not as good, although they were very much better than the unstarched eggs brought earlier in the season, when there was no development at all. Some eggs, I believe, were brought the second day after taking, and I wish to say that I think it is conclusive to my mind that the moving of pike-perch eggs should be delayed until they are well-developed.

In this connection, I would like to ask Prof. Reighard if

it is not possible in most all of the egg development in our hatcheries that the membrane (I think you call it the membrane—I am not familiar with the scientific name), with our trout, for instance, where we are obliged to move the trout eggs, or agitate them at an early period after the eggs are taken, is not broken in being moved about, as well as pike eggs?

PROF. REIGHARD—I think very likely. I do not know of any eggs of the commercial fish handled that have not a structure practically the same as this. In all of them there is this thin membrane and yolk, and under that and practically independent of the membrane is a substance of a doughy consistency, and the rupture of the sac allows that to escape.

MR. CLARK—A year ago last winter we took and shipped eggs from a gravel box, probably 20,000 brook trout eggs, the second day after they were taken from the fish, and another box of the same size, taken at the same time, was left undisturbed. Of the first box we didn't hatch 30 per cent. of the eggs, while of the other we hatched 94 per cent. They were drawn with a syphon.

MR. PAGE—Might I ask what kind of a box it is you keep eggs in?

MR. CLARK—A shad box.

MR. PAGE—A Seth Green shad box?

MR. CLARK—Yes, with wire on the inside of the box, so the eggs can be turned over and the screen cleaned.

MR. MATHER—I would ask the Professor if he has ever seen any smelt eggs? They seem to throw out a little footstool.

PROF. REIGHARD—I have not. That is the case with some eggs; there is a hair-like projection upon them. I am not familiar with those eggs.

MR. MATHER—There is a lot of pedicle-like hairs thrown out from smelt eggs that occasions us a great deal of trouble in smelt hatching.

PROF. REIGHARD—I don't know that the starch would be of any advantage there. It might be that the threads themselves are adhesive, and it might be good.

MR. CLARK—Do you think that most eggs that are adhesive would be benefitted, that we could get better results by the use of starch?

PROF. REIGHARD—If they are adhesive in the same sense these eggs are adhesive, you could. Of course, if you get an egg covered with hair-like projections, it might not be of any assistance; but in any case where the membrane is fairly smooth, the starch is used with some advantage.

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## THE NORWEGIAN FISHERIES.

READ BY CAPT. J. W. COLLINS.

The occupation of fishing is, next to cultivation of the soil, the most important source of livelihood in Norway. According to usual calculations, the number of persons mainly interested in this occupation is one-fifth of the total population.

The fisheries contribute materially to the food of the people and also afford a considerable surplus for export. Until of late years the export consisted almost exclusively of salted and dried products. Strong efforts are, however, now being made to develop the export also of fresh fish.

With most of the other nations who carry on salt-water fisheries on a large scale the deep-sea fishery is the principal one, the fishing taking place in the open sea from decked vessels, usually owned by shareholders, the crew being also engaged on share. In Norway, on the other hand, the fishing takes place almost entirely on the coast from open boats, and the Norwegian fisherman owns, as a rule, his own boat and fishing tackle.

Of the descriptions of fish caught, the cod (*Gadus morrhua*) and the herring (*Clupea harengus*) are the most

important. While these fisheries were formerly of about equal importance to the country, the cod fisheries have in later years given a considerably greater result in value than the herring fisheries.

THE COD FISHERIES.

The great cod fisheries take place principally on the following three divisions of the coast, viz.:

1. The inner and outer coasts of the Lofoten group of islands, between 67° 25′ and 68° 36′ N. lat.

2. The coast line from Stadtland to the entrance of the Trondhjem fjord, including the districts of Sondmore, Romsdalen and Nordmore, or from lat. 62° to 63° 20′.

3. The coast of Finmarken on the boundary of the Arctic Ocean.

From time immemorial the cod has yearly, during the months of January to April, arrived in the first named regions (1 and 2) in large schools, to spawn. In Lofoten the fishing may be said to recur with perfect certainty every year; it has, to be sure, been said that the fish has in some years been present only in smaller quantities, but it cannot with certainty be affirmed that it has in any one year entirely failed to appear.

The cod comes in to Finmarken in the spring months, in pursuit of the great schools of capelan (*Mallotus arcticus*), which serves it for food. Whence it comes and where it goes is as yet an unsolved problem.

The method of fishing, as well as the fishing tackle, are nearly the same for the different districts of the country. In the general collection exhibited in the Norwegian section by the Committee of Bergen for the participation by Norway in the World's Columbian Exposition, characteristic types of boats and apparatus will be found.

The Lofoten fishery is the most important and characteristic of all the fisheries of the country. Every year 7,000 to 8,000 boats manned by about 30,000 men meet to

take part in it. A multitude of fishermen's cabins—each of which serves as lodging for about twelve men—is erected around the fishing stations. Such a cabin may be seen in the Norwegian section of the Fishery Building, where it is used as an office.

The boats are: Gill-net boats with a crew of six to seven men, and a carrying capacity of six to seven tons; long-line boats with three to five men, and up to three and one-half tons capacity, and ordinary small boats for hook and line fishing, rowed by only two or three men. The usual depth in which the fishing takes place is forty to sixty fathoms.

It is estimated that nearly half the fishing time is lost on account of storms, but when the weather permits of uninterrupted fishing, the quantities that may be caught are perfectly astonishing. Thus there were, for instance, landed in Lofoten from the 13th to 22d day of March, 1880, nine and one-quarter millions of codfish.

The entire quantity of cod caught in the great Norwegian winter and spring fisheries was, for the five years 1887-1891, estimated to average about 56.2 millions fish per annum. Of such quantity about 75 per cent. is usually prepared as "Klipfisk" (salted split cod), and 25 per cent. as "Rundfisk" (round dried stockfish).

### THE HERRING FISHERIES.

In the first half of the present century and as late as the close of the sixties, the magnitude of the spring herring fishery was relatively of such importance as to place the other herring fisheries quite in the shade.

The spring herring contains roe or milt, and derives its name from the season of the year in which it is fished, viz., from January to March or April. It is fished on the coast from the Naze to Stadtland, between 58° and 62° N. lat. Like the cod at Lofoten, its migration to the coast is for the purpose of spawning, but contrary to the cod, the

herring has in certain periods failed almost entirely to appear. It is said to have been absent from the coast from 1784 to 1808, and the same may now be said to have been the case since 1873, inasmuch as this fishery, which in good years gave a result of upwards of half a million of barrels, has during the last twenty years usually amounted to only 50,000 to 100,000 barrels. It remains for the future to satisfactorily explain the cause of this irregularity.

In the sixties the so-called "Storsild" (large herring, likewise containing roe or milt) began to come in to the coast of Nordland in immense schools. This fishery, which mainly occurred during October to December, became in short time of great importance. There were, for instance, in the first half of the seventies exported 300,000 to 400,000 barrels annually, and in 1872 even upward of 600,000 barrels. It fell, however, away just as suddenly as it had grown into importance, and in 1875 it ceased entirely.

The herring fishery which in later years has attracted the most attention is, however, the fat-herring (summer herring) fishery. It is no new fishery; in fact, very old, but as long as spring herring and "Storsild" was plentiful it was comparatively neglected.

Contrary to the first mentioned species of herring, the fat-herring is a matje herring, contains neither roe nor milt, but, when of the genuine description, its belly is filled with fat. The best fishing season is August, September and part of October, but it may occasionally commence even as early as July, and it very often extends far into November. This fishery takes place along the entire coast from Bergen to Tromsö, as a rule, however, between 64° and 70° N. lat. The export of fat-herring has, since the middle of the seventies, generally amounted to 500,000 and at times even up to nearly 1,000,000 barrels a year.

The Norwegian fat-herring, which is caught during the autumn months, when it is in its best condition, is con-

sidered to be the finest and most delicious of herrings.

On the southeastern coast of Norway, on both sides of the entrance to the Christiania fjord, a herring fishery has, since the beginning of the eighties, also been carried on with varying success. This fishery occurs about New Years. In 1891–92 the result was very good, and amounted to several hundred thousand barrels. The catch consists of large, full herring (with roe, or milt).

The Norwegian herring fisheries are carried on with gill-nets and drag-nets, perhaps principally the latter. Specimens of both kinds of apparatus are exhibited in the Norwegian section.

Sprats (Brisling—*Clupea sprattus*) are fished for in the autumn with small-meshed drag-nets, chiefly in the fjords between Stavanger and Bergen. It is a small, palatable fish, which is extensively used for anchovies and hermetical preparations. A portion of the catch is also salted in the usual manner.

The above mentioned fisheries (winter and spring cod fisheries and the herring fisheries) supply usually 75 to 80 per cent. of the total value of the Norwegian coast fisheries. The so-called summer fisheries—cod, ling, haddock, cusk, coalfish, sea perch (*Sebastes norvegicus*), halibut, flounder, etc., as well as the mackerel fishery, salmon, sea trout and lobster catch—supply the remaining 20 to 25 per cent. The total annual value of these fisheries has during the period 1887–91 averaged six and three-tenths millions of dollars, calculated at the prices paid at the fishing station. In this amount the home consumption of fresh fish and bait is not included, as this is not included in the official statistics.

Besides her fisheries, Norway also takes part in the following closely allied marine occupations: Whaling in Finmarken, sealing, bottlenose whaling and Arctic Ocean expeditions fitted out from Tromsö, Hammerfest and Vardö.

Whaling in Finmarken is carried on by means of small steamers about 30 tons register. The guns, harpoons and other apparatus used on board these vessels may be seen in the Norwegian section. This occupation dates from the close of the sixties, and has in the eighties been carried on by about thirty steamers, manned by about 500 men, with an annual catch of about 1,000 whales.

To take part in the pursuit of one of these mighty monsters of the deep, is one of the most interesting of sports. If the whale does not die at once, which rarely happens, it dives straight to the bottom and rushes off with the vessel in tow, at a rate which, although the engine works full speed astern, may reach fifteen to sixteen knots. One case has been reported in which this venturesome chase was continued uninterruptedly for twenty-four hours, when the towline was cut, the whale—a real cachelot (humpback)—seeming still in possession of its full strength.

Sealing is carried on in the ocean around the coast of the small island Jan Mayen, between 67° and 75° N. lat. and 5° E. and 17° W. long. (Greenwich). The number of the Norwegian sealers is a little over twenty, exclusively steamers from 200 up to 600 tons register, and manned by about 1,000 men.

Bottlenose whaling is carried on at about the same place as the sealing. The number of vessels engaged has in later years been about sixty, with a crew of about 900 hands; a few of these vessels are steamers, averaging a little more than 100 tons register. The annual catch has been in later years upwards of 2,000 whales.

The Arctic Ocean expeditions are fitted out from the Finmarken ports, Tromsö, Hammerfest and Vardö, with a number of large boats and about fifty small vessels, from thirty to forty tons register. The scene of operation is the Arctic Ocean, the White Sea, and the waters in the vicinity of Spitzbergen and toward Nova Zembla, where eiderdown is collected, fishing carried on and where the capture of the

Greenland shark, the walrus, seal, bottlenose whale, white whale (*beluga*), polar bear and reindeer takes place.

The value of the above named occupations was estimated in 1891 as follows:

| | | |
|---|---|---|
| The whaling in Finmarken | about | $220,000 |
| The sealing | " | 250,000 |
| The bottlenose whaling | " | 200,000 |
| The Arctic Ocean expeditions | " | 100,000 |

With respect to the export trade, reference is made to the statistical tables hereto attached, which were prepared by the Norwegian Statistical Bureau in Christiania, and which give the quantities and values of the most important fishery products, as well as the products of sealing and whaling exported from Norway, in the period 1880 to 1891. As will be observed, the average annual value of the export in that period amounted to about $12,000,000, quite a respectable sum for a country of only 2,000,000 inhabitants. The fisheries products are also the most important articles of export from the country. Next to them come the products of the timber industries with about an equally large amount.

### PUBLIC MEASURES.

It may be said that it is only within the last twenty years that the Government has taken any active steps for the promotion of the fisheries. Government superintendence, which, however, is chiefly to be regarded as a police measure, is established in connection with several of the large fisheries; telegraph and telephone lines have been constructed, postal communications extended and arranged with a special view to the fisheries; the sounding and laying down on charts of the ocean banks is proceeding rapidly; by means of official reports the public is kept posted on the progress and results of the various fisheries, and, if a large school of fish comes into a remote place, temporary telegraph stations are, if necessary, established there-

The statistics of the fisheries have been placed on systematic lines, which have gained general approval for exact. ness and completeness. Various laws have been promulgated. A small sum is appropriated annually for the purpose of practical scientific investigations. The long stretch of coast has been divided into four districts, for each of which an inspector of fisheries is appointed. A separate inspector, with two assistants, has, besides, been appointed for the fresh-water fisheries.

A law of May 24, 1873, provides for the establishment of harbor works, beacons and moorings in the fishing districts, the expenditure for which is covered by the interest from a special fund, which on June 30, 1892, amounted to $155,000, and from a tax placed on the products of the fisheries. The income from these sources has in the last years amounted to about $100,000 annually. It is expended, together with an appropriation from the public treasury, and is applied according to special instruction by the Storthing (Congress). The treasury appropriation is usually made in the proportion of one-third to two-thirds income from the special fund and taxes.

Three separate funds, with an average annual income of $50,000, derived from a tax placed on the fish products, provides for medical relief during the great fisheries. This relief measure embraces free medical care of all persons engaged in the fisheries, the establishment and maintenance of hospitals and, as far as the funds permit, other enterprises for the benefit and comfort of the fishing population.

Selskabet for de Norske Fiskeriers Fremme (the society for the promotion of Norwegian fisheries) was established in Bergen in 1879. It has thirteen branches and subdivisions spread over the country, and about 2,000 members. Its annual income now amounts to about $15,000. Of that amount 75 per cent. is Government grant, and 25 per cent. is derived from subscriptions and private contributions.

Several Fishery Museums have also have established. Since 1882 the Society has issued a quarterly magazine, *Norsk Fiskeritidende* (Norwegian Fisheries Magazine). The Government has established and provides for the maintenance of a fisheries laboratory, with a school of instruction attached, in Bergen, and a fisheries school in Nordland. A biological institute has also been established in Bergen, chiefly with the view of facilitating investigations of benefit to the fisheries. Foreign scientists have admission to this institute.

Fisheries exhibitions are frequently held in the country.

An import duty is placed upon salt, which goes to the treasury and amounts annually to from $80,000 to $120,000. As most of the salt imported is consumed in the service of the fisheries, and as no drawback is allowed on export, the greater part of this burden falls upon the fishing occupation.

KR. LEHMKUHL,
Chairman of Society for Promotion of Norwegian Fisheries, Bergen, Norway.

CAPT. COLLINS—I think, Mr. President, there are some sentences in this paper that deserve attention, and I would be glad to hear an expression from the gentlemen present concerning them. You will notice that a statement is made here that in that country there are maintained several fishery museums, and the thought has occurred to me whether it would not be a good thing for the State Commissioners—those men who are devoting the best years and the best efforts of their lives to promoting the advance and improvement of the fisheries and the maintenance of fish in our streams and lakes—to take some measures to collect, in a systematic way, such matter as they can which might in time constitute a collection worthy of the name of a museum, which would be almost invaluable for reference to their successors.

All of you know, of course, that in Washington there has been gathered a large collection of this character, but

it is not always convenient, I take it, for men interested in these subjects, who are carrying on the work in the States, to go to Washington to study any particular form of net or line or hook, or many other things which might naturally come up for consideration. I simply make mention of this to call the Society's attention to it in a special manner. The statement is also made, though it is known I think to every one here, that fisheries exhibitions are freqently held in the country. In this country, outside of the exhibition that is annually held at Newberne, N. C., I do not know that any attempt has ever been made to have what might be termed a fisheries exhibit, except in connection with some exposition. I believe it would be a matter worthy of consideration by this Society whether or not it would be beneficial to fishing and fishculture and its interests, to hold such exhibits from time to time in the different States. It may be true that it might not be possible to bring together such large collections as might be assembled at some particularly great international fisheries exhibition, but I believe it is true that if from time to time exhibits could be held embracing not only the living fish but also representative of the apparatus, methods of fishing and of fishculture, the public would be much edified, and the work which is being carried on in the various States could be made known to them better than it is now known. I think it is a duty we owe ourselves, that the Society should give this matter some attention.

## TOTAL VALUES OF THE SEA FISHERIES OF NORWAY DURING THE YEARS 1880–1891.

(OYSTERS EXCEPTED.)

| YEAR. | CODFISH. | HERRING AND SPRAT. | MACKEREL. | THE SUMMER FISHERIES OF COALFISH LING, ETC. | SALMON AND TROUT. | LOBSTER. | TOTAL. |
|---|---|---|---|---|---|---|---|
| | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. |
| 1880 | 12,540,000 | 7,103,000 | 696,000 | 1,448,000 | 382,000 | 405,000 | 22,574,000 |
| 1881 | 10,925,000 | 4,962,000 | 769,000 | 2,175,000 | 401,000 | 377,000 | 19,609,000 |
| 1882 | 12,724,000 | 3,451,000 | 699,000 | 2,491,000 | 321,000 | 423,000 | 20,109,000 |
| 1883 | 9,942,000 | 8,447,000 | 742,000 | 4,366,000 | 386,000 | 440,000 | 24,323,000 |
| 1884 | 15,536,000 | 4,295,000 | 735,000 | 2,899,000 | 495,000 | 418,000 | 24,378,000 |
| 1885 | 11,012,000 | 3,965,000 | 782,000 | 2,499,000 | 590,000 | 398,000 | 19,186,000 |
| 1886 | 12,570,000 | 5,549,000 | 765,000 | 2,465,000 | 493,000 | 428,000 | 22,270,000 |
| 1887 | 8,054,000 | 2,958,000 | 554,000 | 2,248,000 | 545,000 | 395,000 | 14,754,000 |
| 1888 | 12,911,000 | 4,637,000 | 719,000 | 2,535,000 | 632,000 | 414,000 | 21,848,000 |
| 1889 | 15,402,000 | 3,836,000 | 384,000 | 2,631,000 | 651,000 | 402,000 | 23,306,000 |
| 1890 | 14,075,000 | 4,141,000 | 512,000 | 2,448,000 | 656,000 | 366,000 | 22,198,000 |
| 1891 | 14,111,000 | 6,763,000 | 659,000 | 3,328,000 | 875,000 | 369,000 | 26,105,000 |

## EXPORT OF FISH AND THE PRINCIPAL PRODUCTS OF FISH, INCLUDING SEAL AND WHALE FROM NORWAY, DURING THE YEARS 1880–1891.

### QUANTITIES.

| YEAR | CODFISH. | | HERRING. | | OTHER SEA FISH PICKLED | ANCHOVIES, SPRAT, PICKLED | MACKEREL HERRING AND OTHER FRESH FISH, SALMON, EXCEPTED. | SALMON. | | LOBSTERS FRESH. | FISH-MEAL. | SKINS. | | | | WHALEBONE. | COD-FISH ROE. | FISH GUANO. | SEAL AND WHALE BLUBBER. | FISH, SEAL AND WHALE OIL. | FISH OIL GROUNDS. | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SALTED (KLIP-FISH. | DRIED STOCK-FISH. | PICKLED. | SMOKED. | | | | FRESH. | SMOKED. | | | POLAR BEAR. | SEAL. | WALRUS. | WHITE-FISH. | | | | | | | |
| | KILOG. | KILOG. | HECTOL. | KILOG. | HECTOL. | HECTOL. | KILOG. | KILOG. | KILOG | NUMBER. | KILOG | KILOG | KILOG. | KILOG | KILOG. | KILOG. | HECTOL | KILOG. | HECTOL | HECTOL | HECTOL | |
| 1880 | 52,962,300 | 19,252,490 | 536,333 | 115,691 | 118,348 | 11,755 | 2,218,830 | 283,230 | 407 | 1,990,784 | 1,278 | 1,472 | 470,934 | 36,880 | 26,065 | 21,720 | 77,630 | 8,769,990 | 12,284 | 168,555 | 1,303 | 1880 |
| 1881 | 41,918,720 | 18,876,200 | 1,090,623 | 354,109 | 167,275 | 15,574 | 1,976,100 | 379,670 | 2,980 | 1,001,981 | 1,108 | 176 | 229,031 | 37,300 | 18,840 | 17,120 | 52,750 | 8,344,550 | 7,002 | 124,916 | 1,776 | 1881 |
| 1882 | 40,120,360 | 14,907,170 | 719,095 | 153,857 | 113,755 | 10,859 | 1,870,580 | 254,820 | 1,707 | 1,324,454 | 2,180 | 128 | 390,396 | 20,830 | 3,710 | 46,900 | 66,451 | 6,232,600 | 11,188 | 100,775 | 15 | 1882 |
| 1883 | 31,452,920 | 10,907,280 | 663,982 | 123,436 | 80,158 | 9,141 | 1,965,450 | 424,480 | 1,418 | 1,089,391 | 1,200 | 288 | 542,412 | 66,910 | 27,380 | 24,490 | 35,633 | 7,001,930 | 24,017 | 82,654 | 774 | 1883 |
| 1884 | 37,665,880 | 13,874,890 | 740,807 | 147,122 | 92,962 | 9,313 | 3,774,540 | 447,130 | 1,195 | 940,160 | 1,130 | 479 | 492,777 | 7,610 | 22,140 | 135,700 | 40,125 | 8,081,200 | 18,712 | 125,262 | 173 | 1884 |
| 1885 | 37,372,110 | 16,829,890 | 697,532 | 223,236 | 87,609 | 11,124 | 7,048,305 | 627,080 | 930 | 835,398 | 830 | 1,885 | 241,433 | 30,000 | 15,160 | 83,360 | 63,914 | 7,949,130 | 2,225 | 146,770 | .... | 1885 |
| 1886 | 41,491,200 | 15,869,330 | 811,156 | 586,001 | 129,002 | 11,066 | 16,086,690 | 523,320 | 2,200 | 1,150,957 | 778 | 869 | 350,917 | 38,230 | 10,740 | 121,560 | 59,203 | 9,052,250 | 3,242 | 168,565 | .... | 1886 |
| 1887 | 42,207,860 | 17,477,300 | 1,126,002 | 1,174,492 | 116,247 | 18,269 | 11,624,250 | 657,010 | 2,788 | 888,163 | 2,360 | 656 | 373,253 | 86,290 | 2,280 | 126,700 | 60,165 | 6,412,420 | 2,760 | 159,656 | .... | 1887 |
| 1888 | 42,817,520 | 20,434,150 | 888,328 | 1,799,392 | 129,558 | 12,069 | 3,492,190 | 732,000 | 602 | 935,404 | 1,025 | 576 | 503,441 | 18,451 | 12,950 | 91,420 | 52,023 | 7,845,490 | 3,967 | 201,583 | 868 | 1888 |
| 1889 | 47,479,240 | 18,346,960 | 1,054,695 | 1,774,147 | 126,380 | 19,809 | 9,397,400 | 692,360 | 801 | 759,910 | 735 | 1,794 | 404,584 | 46,508 | 2,772 | 53,550 | 51,720 | 6,944,160 | 2,662 | 207,498 | 624 | 1889 |
| 1890 | 55,577,120 | 18,565,870 | 829,145 | 2,196,686 | 150,917 | 16,991 | 8,036,530 | 758,610 | 1,222 | 660,055 | 528 | 491 | 440,750 | 17,770 | 3,890 | 89,960 | 87,706 | 8,630,680 | 846 | 236,701 | 818 | 1890 |
| 1891 | 45,069,600 | 14,400,100 | 788,809 | 1,558,703 | 136,049 | 11,854 | 10,907,550 | 1,026,790 | 1,326 | 566,703 | 11,554 | 1,271 | 465,851 | 26,840 | 617 | 94,500 | 42,447 | 7,102,290 | 5,018 | 181,691 | .... | 1891 |

### VALUES.

| YEAR | CODFISH. | | HERRING. | | OTHER SEA FISH PICKLED. | ANCHOVIES, SPRAT, PICKLED. | MACKEREL, HERRING, AND OTHER FRESH FISH, SALMON EXCEPTED. | SALMON, FRESH. | LOBSTERS, FRESH. | SKINS. | | | WHALE BONE. | CODFISH ROE. | FISH GUANO. | SEAL AND WHALE BLUBBER. | FISH, SEAL AND WHALE OIL. | OTHER PRODUCTS. | TOTAL VALUES. | YEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SALTED (KLIP-FISH). | DRIED (STOCK FISH). | PICKLED. | SMOKED. | | | | | | SEAL. | WALRUS. | WHITE-FISH. | | | | | | | | |
| | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER | KRONER. | KRONER. | KRONER | KRONER. | KRONER | KRONER. | |
| 1880 | 12,304,500 | 5,274,200 | 9,504,200 | 37,000 | 805,900 | 704.100 | 461,900 | 453,200 | 396,300 | 526,600 | 9,200 | 49,500 | 195.500 | 1,552,600 | 1,315,500 | 270,300 | 5,294.800 | 28.200 | 39,183,500 | 1880 |
| 1881 | 16,012,000 | 6,134,800 | 16,280.300 | 113,300 | 1,574,200 | 734,500 | 418.700 | 569,500 | 400,800 | 301,200 | 11,200 | 22,600 | 154,100 | 1,091.900 | 1,335,100 | 252,100 | 5,438,300 | 83,300 | 50,927,900 | 1881 |
| 1882 | 17,653,000 | 6,727,100 | 12,150,900 | 55,400 | 812,800 | 523,100 | 447,800 | 407,700 | 529,800 | 620,700 | 16,700 | 5,900 | 24,400 | 1,229.300 | 1.121,900 | 402.800 | 5,382,500 | 86,700 | 48,198,500 | 1882 |
| 1883 | 16,041,000 | 5,487,900 | 11,567,000 | 49.400 | 566,900 | 306,000 | 516,800 | 551,800 | 490,200 | 745,800 | 60,200 | 38,300 | 9,800 | 1,567,900 | 1,120,300 | 960,700 | 4,430,100 | 120,500 | 44.630,600 | 1883 |
| 1884 | 13,183,100 | 5,625,400 | 10,555,700 | 44,100 | 608,700 | 251,400 | 772,700 | 625,900 | 441,900 | 492,800 | 6,800 | 26,600 | 95,000 | 1,524,800 | 1,131.400 | 636,200 | 5,706,300 | 182,000 | 41.910,800 | 1884 |
| 1885 | 11,847,000 | 5,122,500 | 8,128,500 | 58,000 | 574,500 | 318,000 | 1,198,900 | 783.900 | 401,000 | 289,700 | 24,000 | 15,200 | 58,400 | 1,246,300 | 953,900 | 71,200 | 5,228,400 | 230.800 | 36,550,800 | 1885 |
| 1886 | 10,787,700 | 5,387,100 | 9,625,600 | 117,200 | 854,600 | 287,860 | 1,945,100 | 680,300 | 517,900 | 386,000 | 22,900 | 11,800 | 109,400 | 1,065,700 | 995,700 | 100,500 | 5,140,500 | 172,000 | 38,207,800 | 1886 |
| 1887 | 13,928,600 | 5,883,500 | 9,777,400 | 234,900 | 765,700 | 348,400 | 1,226,600 | 854,100 | 444,100 | 466,600 | 38,800 | 1,800 | 126,700 | 1,263,500 | 641.200 | 70,500 | 4,616,300 | 119,400 | 40,808,100 | 1887 |
| 1888 | 15,414,300 | 6,719,500 | 11,217,700 | 449,800 | 1,099,200 | 391,500 | 1,783,500 | 951.600 | 561,200 | 704,800 | 8,300 | 10,400 | 137,100 | 998.400 | 863,000 | 119,000 | 5,609,900 | 96,500 | 47,125,700 | 1888 |
| 1889 | 16,617,700 | 6,095,100 | 10,865.400 | 283,900 | 1,290,800 | 531,900 | 1,053,800 | 1,003,900 | 455.900 | 505,700 | 20,900 | 1,900 | 85,700 | 801,700 | 833,300 | 79.900 | 5,726,900 | 95,700 | 46,350,100 | 1889 |
| 1890 | 17,784,700 | 6,703,200 | 10,313,900 | 395,400 | 1,593,400 | 321,400 | 845,300 | 1,137,900 | 429,000 | 440,800 | 8,000 | 2,900 | 188.900 | 1,052,500 | 1,078,800 | 25.400 | 6,811,800 | 108,900 | 49,242,200 | 1890 |
| 1891 | 18,478,500 | 5,995,900 | 9,782,600 | 311,700 | 1.733,200 | 237,800 | 1,142,200 | 1,386,200 | 379,700 | 559,000 | 10,700 | 400 | 203,200 | 776,800 | 894,900 | 155,600 | 5,953,600 | 134,600 | 48,136,600 | 1891 |

## ODUCTS OF FISH, INCLUDING SEAL AND WHALE
## RING THE YEARS 1880–1891.

### QUANTITIES.

| SALMON. | | LOBSTERS FRESH. | FISH-MEAL. | SKINS. | | | | WHALE-BONE. | COD-FISH ROE. | |
|---|---|---|---|---|---|---|---|---|---|---|
| RESH. | SMOK-ED. | | | POLAR BEAR. | SEAL. | WAL-RUS. | WHITE-FISH. | | | GU |
| ILOG. | KILOG | NUMBER. | KILOG | KILOG | KILOG. | KILOG | KILOG. | KILOG. | HECTOL | K |
| 83,230 | 407 | 1,990,784 | 1,278 | 1,472 | 470,934 | 36,880 | 26,065 | 21,720 | 77,630 | 8,7 |
| 79,670 | 2,980 | 1,001,981 | 1,108 | 176 | 229,031 | 37,300 | 18,840 | 17,120 | 52,750 | 8,3 |
| 54,820 | 1,707 | 1,324,454 | 2,180 | 128 | 390,396 | 20,830 | 3,710 | 46,900 | 66,451 | 6,2 |
| 24,480 | 1,418 | 1,089,391 | 1,200 | 288 | 542,412 | 66,910 | 27,380 | 24,490 | 35,633 | 7,0 |
| 47,130 | 1,195 | 940,160 | 1,130 | 479 | 492,777 | 7,610 | 22,140 | 135,700 | 40,125 | 8,0 |
| 27,080 | 930 | 835,398 | 830 | 1,885 | 241,433 | 30,000 | 15,160 | 83,360 | 63,914 | 7,9 |
| 23,320 | 2,200 | 1,150,957 | 778 | 869 | 350,917 | 38,230 | 10,740 | 121,560 | 59,203 | 9,0 |
| 57,010 | 2,788 | 888,163 | 2,360 | 656 | 373,253 | 86,290 | 2,280 | 126,700 | 60,165 | 6,4 |
| 32,000 | 602 | 935,404 | 1,025 | 576 | 503,441 | 18,451 | 12,950 | 91,420 | 52,023 | 7,3 |
| 92,360 | 801 | 759,910 | 735 | 1,794 | 404,584 | 46,508 | 2,772 | 53,550 | 51,720 | 6,9 |
| 58,610 | 1,222 | 660,055 | 528 | 491 | 440,750 | 17,770 | 3,890 | 89,960 | 87,706 | 8, |
| 26,790 | 1,326 | 566,703 | 11,554 | 1,271 | 465,851 | 26,840 | 617 | 94,500 | 42,447 | 7, |

### VALUES.

| LMON, ESH. | LOBSTERS, FRESH. | SKINS. | | | WHALE BONE. | CODFISH ROE. | FISH GUANO. | SE AN WH BL BE |
|---|---|---|---|---|---|---|---|---|
| | | SEAL. | WALRUS. | WHITE-FISH. | | | | |
| ONER. | KRONER. | KRONER. | KRONER. | KRONER. | KRONER | KRONER. | KRONER. | KRO |
| 53,200 | 396,300 | 526,600 | 9,200 | 49,500 | 195.500 | 1,552,600 | 1,315,500 | 270 |
| 69,500 | 400,800 | 301,200 | 11,200 | 22,600 | 154,100 | 1,091,900 | 1,335,100 | 252 |
| 07,700 | 529,800 | 620,700 | 16,700 | 5,900 | 24,400 | 1,229.300 | 1,121,900 | 402 |
| 51,800 | 490,200 | 745,800 | 60,200 | 38,300 | 9,800 | 1,567,900 | 1,120,300 | 960 |
| 25,900 | 441,900 | 492,800 | 6,800 | 26,600 | 95,000 | 1,524.800 | 1,131,400 | 636 |
| 83.900 | 401,000 | 289,700 | 24,000 | 15,200 | 58,400 | 1,246,300 | 953,900 | 71 |
| 80,300 | 517,900 | 386,000 | 22,900 | 11,800 | 109,400 | 1,065,700 | 995,700 | 100 |
| 54,100 | 444,100 | 466,600 | 38,800 | 1,800 | 126,700 | 1,263,500 | 641.200 | 70 |
| 51.600 | 561,200 | 704,800 | 8,300 | 10,400 | 137,100 | 998.400 | 863,000 | 119 |
| 03,900 | 455.900 | 505,700 | 20,900 | 1,900 | 85,700 | 801,700 | 833,300 | 79 |
| 37,900 | 429,000 | 440,800 | 8,000 | 2,900 | 188.900 | 1,052,500 | 1,078,800 | 25 |
| 86,200 | 379,700 | 559,000 | 10,700 | 400 | 203,200 | 776,800 | 894,900 | 155 |

## VHALE FROM NORWAY,

| COD-FISH ROE. | FISH GUANO. | SEAL AND WHALE BLUBBER. | FISH, SEAL AND WHALE OIL. | FISH OIL GROUNDS. | YEAR |
|---|---|---|---|---|---|
| HECTOL | KILOG. | HECTOL | HECTOL | HECTOL | |
| 77,630 | 8,769,990 | 12,284 | 168,555 | 1,303 | 1880 |
| 52,750 | 8,344,550 | 7,002 | 124,916 | 1,776 | 1881 |
| 66,451 | 6,232,600 | 11,188 | 100,775 | 15 | 1882 |
| 35,633 | 7,001,930 | 24,017 | 82,654 | 774 | 1883 |
| 40,125 | 8,081,200 | 18,712 | 125,262 | 173 | 1884 |
| 63,914 | 7,949,130 | 2,225 | 146,770 | .... | 1885 |
| 59,203 | 9,052,250 | 3,242 | 168,565 | .... | 1886 |
| 60,165 | 6,412,420 | 2,760 | 159,656 | .... | 1887 |
| 52,023 | 7,845,490 | 3,967 | 201,583 | 868 | 1888 |
| 51,720 | 6,944,160 | 2,662 | 207,498 | 624 | 1889 |
| 87,706 | 8,630,680 | 846 | 236,701 | 818 | 1890 |
| 42,447 | 7,102,290 | 5,018 | 181,691 | .... | 1891 |

| FISH UANO. | SEAL AND WHALE BLUBBER. | FISH, SEAL AND WHALE OIL. | OTHER PRODUCTS. | TOTAL VALUES. | YEAR |
|---|---|---|---|---|---|
| RONER. | KRONER | KRONER. | KRONER | KRONER. | |
| ,315,500 | 270,300 | 5,294.800 | 28.200 | 39,183,500 | 1880 |
| ,335,100 | 252,100 | 5,438,300 | 83,300 | 50,927,900 | 1881 |
| ,121,900 | 402.800 | 5,382,500 | 86,700 | 48,198,500 | 1882 |
| ,120,300 | 960,700 | 4,430,100 | 120,500 | 44,630,600 | 1883 |
| ,131,400 | 636,200 | 5,706,300 | 182,000 | 41,910,800 | 1884 |
| 953,900 | 71,200 | 5,228,400 | 230.800 | 36,550,800 | 1885 |
| 995,700 | 100,500 | 5,140,500 | 172.000 | 38,207,800 | 1886 |
| 641.200 | 70,500 | 4,616,300 | 119,400 | 40,808,100 | 1887 |
| 863,000 | 119,000 | 5,609,900 | 96,500 | 47,125,700 | 1888 |
| 833,300 | 79.900 | 5,726,900 | 95,700 | 46,350,100 | 1889 |
| ,078,800 | 25.400 | 6,811,800 | 108,900 | 49,242,200 | 1890 |
| 894,900 | 155,600 | 5,953,600 | 134,600 | 48.136,600 | 1891 |

## PLANT YEARLINGS WHERE NEEDED.

BY WM. F. PAGE.

The term "yearling" as heretofore used (and as must from the necessity of the case continue to be used) is faulty in that it signifies only that the fish under discussion has reached a certain age, acquired a certain degree of intelligence, and cost a certain sum for attendance and food. The cost of a yearling will depend, other things being equal, upon the general cost of living in the locality in which it has been grown. The intrinsic value of the yearling for stocking purposes, if normally developed and in health, should depend upon its size, as it certainly would if the fish were to be used for the table. Latitude and elevation above the sea regulate to a large extent the possibilities of any particular hatchery for raising fish within a stated period to a given size. There is in the United States a variation in this respect of nearly 1,000 per cent. All consideration of the relative values of fry and yearlings for stocking purposes should be confined to the product of some particular hatchery or at least hatcheries under like climatic and hydrographic conditions.

In the past, particularly at the last meeting, the opponents of raising fish to yearlings prior to planting have used arguments which would fall under the following heads:

(a) The excessive cost.

(b) Its want of analogy to other processes.

(c) The large number of fish which would avoidably be lost, and

(d) Its want of permanent and commensurate results.

To an answer to these points I ask your attention.

The main element of cost heretofore discussed has been that of food. It is, in fact, almost, if not altogether, the chief factor of expense in raising from fry to yearlings. The attendance need not be counted (except perhaps in

some particular case), for the preparation of the food and the feeding of it to the fish can safely be intrusted to the care-taker, who looks after the brood stock and other property.

There are among fishes, in common with other animals, several dietaries, some followed from a matter of choice, some from necessity, and others from ignorance on the part of the attendant. They may for convenience be thus classified: First, bare subsistence diet, merely sustaining life and resulting in stunted, deformed fish or starvation; second, healthy diet, promoting normal growth and development; third, fattening diet, fitting for heaviest marketable weight, and fourth, over-fattening diet, causing a temporary or permanent suppression of the functions of the reproductive organs, a partial or total destruction of the eyes and inflammation of the intestines, frequently resulting in death. The first and fourth of these diets have killed very many fish, the second has hurt none and the third is outside the proper object of this paper. The question largely turns upon what constitutes a healthy diet? What does it cost? and is that cost excessive? No phase of this question is more obscure, more diversified in practice or richer in possibilities.

In the following paper, wherever reference is made to the "daily rations," "allowance," or "formulas," the amount and proportions given apply to yearling trout unless otherwise stated, the intention being to express only the artificial food supplied without taking into account the natural food the fish secure. Nor have I considered the highly important though ever-varying elements of "initial vitality," "range," and "space" in discussing the growth and size acquired by fish at different establishments. It will rarely or never happen that these conditions are identical at different establishments, for we know that at any one they are found varying from year to year and frequently in the same season. In our considerations of ar-

tificial food and growth we must for the present disregard, or assume as constant, the initial vitality, natural food, range and space.

For convenience of study I have adopted as a unit "the average daily rations in pounds per thousand yearling trout." I am aware that the unit would be more expressive and exact if it were based upon the number of pounds of fish rather than upon the number of fish to be fed. I have the data of the amount and character of food and rate of growth of the fish at sixteen trout-cultural establishments in the United States and Great Britain, the régime and results of which may fairly be assumed as typical of fishculture in general. These data present the astounding variation in the daily rations per thousand yearlings of from $2\frac{1}{4}$ oz. of animal (or flesh) food, in ponds containing very little natural food, to 10 lbs. of animal food in ponds abounding in natural food. I have calculated the weight of one thousand of the average yearling trout raised at these places to be 52.75 lbs. and the average daily rations to be $3\frac{1}{2}$ lbs. In other words, the average allowance for yearling trout is $6\frac{1}{2}$% of their weight. This, it seems to me, is out of all proportion to their necessities, and certainly is not warranted by analogy. It is true, as before pointed out, that the rate of growth depends to a large extent upon the location of the hatchery, and the corollary follows that the food allowance will also vary with the location. The allowance of a hatchery in a warm section cannot be considered a guide for one in a colder or more elevated region. For instance, trout reared in the Ozarks acquire a weight 700% in excess of those grown in the mountains of Colorado. The Colorado trout could not consume the allowance of the Ozark trout, and the Ozark trout would stunt or starve on the Colorado allowance. On this subject Mr. Stone says in "Domesticated Trout" (page 236): "The quantity [of food] varies with the season, the quality, quantity and temperature of the water,

and other circumstances, and cannot be definitely stated. Green says 5 lbs. for a thousand two-year-olds. I should say this would be an average feed through the year. I think it safe to say that under favorable circumstances large trout of any age will eat 1-50 of their weight in summer, that 1% of their weight will keep them in good condition through the year, and that they would do very well on half that allowance." Dr. Slack, in his book, "Trout Culture," stated that his brood stock throve very well on ⅛ of 1% of their weight per day.

In the report of the United States Commission of Fish and Fisheries for 1884 is a translation of Mr. Carl Nicklas's book entitled "Pond Culture." In this work Mr. Nicklas enters exhaustively into the character and quantity of food necessary for fish On page 112 he says: "As there are no data on the subject, it will be difficult to lay down exact rules as to the quantity of food. It will be correct to presume, at least approximately, the same principles will have to serve as a basis as those prevailing in the feeding of cattle, and we shall, therefore, be enabled to fix a standard which will come as near the true one as possible." Reasoning on this basis, Mr. Nicklas concludes that 1,000 lbs. of carp will require 15 lbs. or 1½% of their weight of food per day. When we consider that a carp will consume, and probably requires, more food than a trout, we see that these three writers are in fairly close accord; and that the average practice of feeding 6½% of their weight to trout is in excess of the amount required. However, it must not be forgotten that these growing yearlings would most likely need a higher per cent. than the matured fish; but I cannot believe that the process of growing would require six times the material found necessary for maintenance after growth was accomplished.

So much as to the amount of food necessary, and that given in actual practice. Let us look now at what constitutes the food of trout under domestication. At sixteen

places I find liver is used. Curd, horse meat and mush at three place. Maggots, mussels, boiled fish and hens' eggs are each used at different places. At four of the places natural food is very abundant in the waters and largely depended upon for a portion of the year. You are all familiar with these various forms of food, and I shall not make further reference to them except to touch upon the points of natural food and the mixture of vegetable and animal food for trout. No little was said in the meetings of 1891 and 1892 upon the former subject, and I should not now refer to it except that on the part of some an incredulity was expressed as to the possibility of producing an adequate amount of natural food for more than a few hundred fishes. The following letter from Mr. Andrews will, I hope, satisfy the incredulous on this point:

WESTGATE HOUSE, Guilford, England, May 6, 1893.—Dear Sir: In reply to yours of April 18, it gives me great pleasure to comply with your request, and if the following is of any use to you I shall be very glad. I presume you have kept a copy of your letter to me, and I therefore simply answer your questions as numbered.

1. I have two hatcheries, the principal one being at Guilford, with capacity for hatching between 3,000,000 and 4,000,000 ova. The other hatchery is at my ponds at Haslemere, and is smaller.

The principal rearing ponds, and also ponds for the larger fish, are at Crichmere, Haslemere, and are from 200 to 300 feet above sea level.

3. Temperature of the hatching water at Guilford is pretty uniform at 49 to 51°. Temperature at my ponds varies from 49° in winter to 56° in summer. Occasionally it rises 2 or 3° higher, but very seldom.

The quantity of water passing through my Crichmere ponds amounts to nearly a million gallons per diem, and is only very slightly affected by a long drought and not to any visible extent. The place is, moreover, not subject to

flood, as all the springs rise on my grounds. The same applies to the other places which I use as fish farms.

4 and 5. I cannot tell how much liver and horse flesh is given to the yearling fish, but as natural food, viz., *Gammarus pulex*, *Limnæa* and larvæ of all water insects are present in great quantities, I can safely say the artificial food given to the fry is very, very small, and in two out of the three of my sets of ponds no artificial food whatever is given to the fish. We cultivate the natural food to a large extent, leaving one or more ponds every year for the purpose, and it is not an uncommon thing for us to transfer 150 gallons of *Gammarus pulex* and 20 bushels of *Limnæa* from one pond to another.

6. We get yearling fish of *fario*, *levenensis*, *fontinalis* and grayling from 4 in. up to 8 and 10 in. in length in 10 to 11 months, and there is very little difference in size of the four varieties above named. I do not care for the *S. irideus*, and have only had a few which were given me by Sir Jas. Maitland some four or five years ago. I need hardly say that the best yearlings are from fry planted in January and February, and the smaller yearlings are from fry planted later. Our fish begin to spawn late in October, and I have taken eggs as late as March 20, but I place less value on these late ova.

7. Weight of 5 in. yearling is about 350 grains, sometimes 450 grains, and this will apply to *fario*, *levenensis* and *fontinalis*, but grayling are a little lighter, being a slighter made fish. We include *levenensis* in the *fario* variety.

American *fontinalis* do well with me, reaching a large size, and I have breeders of this kind of 4 and 5 lbs. Many of my two-year-old fish weigh 1¾ lbs. and 2 lbs. in the second year, but I do not supply fish as two-year-olds over 12 in. I am, dear sir, yours very truly,

(Signed) THOS. ANDREWS.

It must be evident, I think, to every progressive fishcul-

turist that a change is coming over the spirit of the dream of fishculture, and in view of the fact that this change has its origin in, and is spreading from, the Old World, we must look at our laurels or else abandon the boast that we are the most advanced nation in fishculture. Only one thing can be urged against the new departure, and that is the cost of the land and the construction of the larger plant necessary for such a self-feeding establishment. But when we reflect that in cramped Great Britain private individuals without Government aid have successfully accomplished this thing on a paying basis, we must acknowledge that in broad and comparatively scantily populated America it can be done. If fishculture as a private business expands in this country as I hope to see it, the artificial propagation of natural fish food will be undertaken and accomplished. And to him who first does it will come the cream of the profits of the business. It will be by this process we will secure a rational, healthy diet at a minimum cost.

But however willing and ready we might be to take up the propagation of natural fish food on a scale commensurate with the demands, such an undertaking would necessarily be slow in its accomplishment, and probably considerable time would elapse before it became sufficiently developed to be understood and relied upon. In the twentieth meeting Mr. Seal told us how easy it was to secure a start and propagate natural food in any desired quantity. My own experiments fully confirm his statements, and by consent of the Commissioner I hope soon to test them on a larger scale. In the last meeting Mr. Fairbank told us how abundantly and cheaply this food produced itself at his place, and how well his fish throve upon it. Pending the development of this new method, which I feel sure will yet be undertaken and prosecuted by Americans, I submit for your consideration the methods of feeding trout as practiced at Wytheville and Neosho Stations,

of the United States Fish Commission, and also at the Troutdale Fish Farm, at Mammoth Spring, Ark. The method followed at these three places is not, so far as I know, prosecuted elsewhere; the differentiation consisting in an admixture of vegetable matter with the flesh or animal matter, heretofore constituting the sole food for trout under domestication. A few notes on the methods of preparing and administering this food at the Neosho Station will illustrate the method of the three places where it is used. A thick mush is made by cooking "shorts" or mill-middlings in boiling water, which, after it has thoroughly cooled and stiffened, is mixed with liver ground to a fineness suitable to the size of the trout to be fed. The very young trout have never been subjected to this diet (though it is not doubted that they could be induced to eat it), but they are started and kept upon a pure beef liver diet until they are thoroughly trained to congregate for their food. When the fry have been on liver for about two months, we commence to mix in a little mush, and gradually increase the proportion of mush (and quantity of food) until by the time they are six months old the mush and liver are in equal proportions. After that time the addition of mush is made freely, so that when the fish are yearlings the liver may be reduced to a minimum.

Exigencies have arisen, making it desirable to economize on liver. At such times we have not hesitated to put the trout on a diet of pure mush. They do not allow this food to sink to the bottom and eat it only when pressed by hunger. On the contrary, they rise to the surface, sometimes eat it in the air, and rarely or ever allow a particle to reach the bottom. To 1,000 yearling trout we have been giving a daily average of 1.87 lbs. of this mixture, in the proportion of 3.79 mush to 1.0 liver. Their average length at one year old was 6 in., and the weight for an average 1,000 was 51.86 lbs. The loss in raising 40,000 trout to

yearlings on this diet was 6 per cent. of the number of fry. That the fish produced by this diet were normal and healthy is beyond all question, and if evidence is wanted it is to be found in that their progenitors, spawning them at two years old, were raised on the exact same diet. The natural question is, what does this food cost? Shorts cost at Neosho, Mo., 90 cents per 100 lbs. One pound of shorts makes 3.6 lbs. of mush. Mush therefore costs one-quarter of a cent per pound. Liver during 1892 was delivered in Neosho from Kansas City for 3½ cents per pound. From this I deduce the cost of an average daily ration for 1,000 yearlings was 1.707 cents. If this food is not cheap enough to suit your views, I then ask your attention to the following condensed history of an experiment in feeding trout which I undertook last summer. On August 9, 12,000 healthy trout fry which had up to that time received the same general treatment and allowance of food as we usually give, were deprived of all animal or flesh food. From that time until they were shipped in February, 1893, not an ounce of animal food was given them, and it is certain that the natural animal food which they might have obtained was the very least. Their allowance throughout this time was 45 lbs. of mush per day, costing a fraction under one cent per 1,000 fish per day. At the end of the year they averaged 4 in. in length, and an average thousand fish weighed 27.5 lbs. The fish were normal and healthy, and though under the average size for Neosho, they were above the average of at least two American establishments.

In closing this branch of the subject, let me say that the food composed of a mixture of animal and vegetable matters more nearly approximates than any other artificial trout food in use, a rational, healthy diet; and when we consider its capabilities of creating and sustaining the heaviest growth in the shortest time, we must admit that it is not an extravagant diet. A study of Mr. Nicklas's article heretofore referred to conclusively shows that fishes

need the smallest proportion of hydrate of carbon; and further, that the best fish food is that containing the largest proportion of nitrogenous materials. He says on page 111: "The most suitable articles of food are blood, horse flesh, fish guano, curds, meat dried and ground fine, refuse from slaughter-houses, etc. All these, however, require to be mixed with other articles of food containing less nitrogen, so as to restore the proper proportion of nutritive substances. On the whole, the food for carp will have to be mixed very much on the same principle as that for cattle and other domestic animals." (In the passage just quoted Mr. Nicklas has reference to carp, but his remarks apply with equal or greater force to trout.) This is just what we claim to be doing in mixing mush with liver. It is probable that we are not at present combining these elements in the best possible proportion for fish, the Neosho formula being 1.0 meat to 3.79 mush, yet I believe we are using a more rational and inexpensive diet than is to be found in any one element of animal substance. If you answer me that the trout is naturally a carnivorous animal, I reply by reminding you that the trout we feed in our ponds are domesticated animals. The jackal and the wolf are carnivorous, but your domesticated dog sickens and dies when restricted to the only food acceptable to his ancient progenitors.

Is the cost excessive? That is something every man must work out for himself. In commercial fishculture the problem is soon solved by reference to the cash account. In governmental work it is a matter between the authorized agents and the legislative body controlling. It depends upon so many things that no one can say the cost is or is not excessive except for a particular locality. A food which we can well afford to use in Missouri is found too costly in the East.

Leaving then the question of expense, let us see wherein does the planting of yearlings lack analogy to other pro-

cesses. Last year the attempt was made to draw a comparison between stocking a stream with fish and raising an orchard, and with the parallel but half drawn it looked rather adverse to the yearling idea; but had the parallel been carried to its legitimate conclusion we would have seen that the young trees to thrive were in constant need of attention and protection. Food, water and protection from enemies all young trees must have, or only the fittest survive. Forgetting or ignoring these fundamental principles of husbandry, it was concluded that because one could raise large trees from small ones, therefore one could to the best advantage stock wild waters with infant fish. There is no true simile at any point between the two processes. In the former case we domesticate the trees, and in the latter case we naturalize the fish. These are widely divergent processes, in so much that in naturalization we omit, or at least, do not extend, the protection always accompanying domestication. A fair comparison cannot be drawn between the two. A fairer comparison might be found in the colonization by man of new countries. Who among the advocates of infant fry planting would support a scheme for colonizing a new America by sending out a cargo of babies? Let us look at this simile and see if it won't parallel better than that of the orchard. The history of the early colonization of this continent and Australia contains accounts of the death from disease, enemies and murder by savages sometimes of entire communities. Truly these were "lambs placed in the lion's den for safekeeping," somewhat on the order recounted (page 83, twenty-first meeting) of planting two-pound lake trout in a lake infested by pickerel. The moral is, if you will put your lambs into lions' dens, don't think it strange if others put their sheep into a sheepfold. But, further, we see that wherever on proper lines colonization has been undertaken, success has crowned the effort, and so it will eventually prove in the naturalization of fish.

As a practical workman, I wish to enter my negation to the doctrine advanced in this Association in the past of the very large percentage of loss unavoidable in raising fry to yearlings. One member last year said if you have good luck with 1,000,000 fry you may have 600,000 fish at the end of the year. In other words, a loss of 40 per cent., and another member placed the unavoidable loss at 50 to 75 per cent. I prefer to look upon these statements as fancy born and not as the expressions of experience. Twenty-five years ago they might have held good. But to-day, with proper appliances and a proper understanding and knowledge of the work, a loss of 75, 50 or even 40 per cent. from fry to yearlings should be considered inexcusable. (This be it understood to apply only to the product of such eggs as have not been subject to transportation.) As touching this matter, I ask your attention to the following quotation from Mr. Livingston Stone's work, "Domesticated Trout" (third edition, page 190): "I must, nevertheless, venture to disagree with them if they mean that there is any necessary inherent cause of death in the young fry which cannot be removed. Some will die, say 5 per cent., though it ought to be less than this, of weak constitutions. They are born into the world so weakly constituted that they cannot stand the wear and tear of life, and must die. I admit there may be perhaps 5 per cent. of these necessary, unavoidable deaths; but that the rest come into being already doomed to premature death, or that young trout have any mysterious or peculiar inherent cause of death in them, any more than young calves, or pigs, or chickens, I do not believe. In the present state of information of the art, young trout fry may be more liable to accidents than other young domesticated creatures, and it may be more difficult to guard against their diseases, but this is another thing. Careless breeding may, and careless hatching will, produce a progeny of young trout of which 90 per cent. will die; but this is also an-

other thing. Careful breeding and hatching will produce trout which are just as likely to live, in my opinion, as the same number of lambs or chickens; and if the young fry die it is not because of any mysterious, innate cause peculiar to them because they are trout, but it is because they were killed, deliberately killed, by external causes, just as much as lambs or chickens are killed by storms, or by parasites, or from starvation or poison. It is true that they are killed from ignorance of their wants, and not from wilful neglect, but it is the same thing abstractly—the cause of death is external and removable, and not innate and necessary. Their wants are peculiar, of course, and more occult and intangible than those of pigs and colts, and to a beginner it will sometimes seem as if they died without being diseased. But if they were as large as pigs and colts and could be studied as easily, I do not think their wants would be found to be any more mysterious or peculiar: and if the cause of disease could be magnified, so as to be observed and studied clearly, I think that no more trout would die when nothing was the matter with them.

"I am further convinced that study and experience will eventually clear this subject, notwithstanding the difficulties which surround it, and that at some time it will be known how to raise trout and make them live, as well as is known how to raise turkeys and chickens. I believe that there are energy and intelligence enough now interested in the cause to accomplish this end. I take this ground, partly because any other is unphilosophical and uncomplimentary to the intelligence of those who are studying the art, and partly because the facts of experience confirm it."

On page 149 of the "History of Howietoun," Sir James Maitland, speaking of a loss of 20 per cent. in a particular lot of *S. levenensis*, says: "This is a very heavy percentage, and is probably 8 per cent. too high," and in another place he gives his losses as 11 per cent. and 13 per

cent. My own experience with healthy eggs and fry is that the loss should not reach 10 per cent. These figures are not guesses. They are founded on actual counts. My method is this: In the spring, about or a little before the average time of planting fry, our young trout are transferred from the hatching troughs to the outdoor pools. We commence by taking out 500 of the most advanced fry and putting them into a pool by themselves. No other fry are added to them until they have been taught to readily congregate in the pool for their food. This training occupies two, three, four or five days, depending upon the fish and the condition of the weather. When they are thoroughly trained in this, a thousand more fry are added. It is expected, and rarely fails, that the 500 trained fish teach the 1,000 new fish to assemble at feeding times. Day by day we add fry in lots of 1,000 until the pool receives its quota. Now, the test of the whole matter comes in the succeeding fall, when the messenger brings his orders for so many yearling fish. Let us suppose his order calls for 5,830 fish. Then, that is just the number which we give him. But how? As a shipment of fry was formerly determined by counting a pan of 500 and estimating the balance? By no means. The fish are counted. At the Neosho Station three men ordinarily require less than two hours from start to finish in counting and loading an average carload of yearlings. The captain of the car is at liberty to supervise and check the count. At its completion he gives a receipt for the number of fish. This receipt is subject to a check in that the messenger must obtain a receipt or receipts from the final recipient or recipients of the fish for the like number, or stand the onus of having lost the fish in transit. The total of the receipts given by the messengers, subtracted from the total of the fry counted into the pools, represents the loss in raising from fry to yearlings. A little while back I made the statement that this loss need not exceed 10 per cent. Let us see what

this loss has been during the history of the Neosho Station. In 1890, on rainbow trout, 9 per cent.; in 1891, on rainbow trout, 7 per cent.; on Von Behr trout, 34 per cent.; on brook trout, 26 per cent.; in 1892, on rainbow trout, 6 per cent., and on brook trout, 8 per cent. The average of these six instances is 15 per cent. This is 5 per cent. too high, and was occasioned by the excessive loss of 34 per cent. and 26 per cent. respectively, in the Von Behr and brook trout of 1891. In the report of these two lots of fish, written before this loss occurred, it was stated that they were very inferior lots of fish, with low degree of vitality, and unlikely to reach maturity. But the rainbow eggs of the seasons of 1890 and 1891 were strong and healthy, and their fry suffered a loss of only 9 per cent. and 7 per cent. respectively. The lowest loss, 6 per cent., was in the lot of rainbows raised from eggs spawned at Neosho—from eggs which had never undergone transportation. I have a belief that the very best results in fishculture will be attained by hatching from eggs which have not been subjected to transportation.

The successes which have attended our methods of raising trout fry to yearlings in pools are in the nature of a guarantee or proof that in principle it is very near correct. How different it is from the practice of planting several thousand fry at one time in one place. Some eighteen years ago, when we were getting ready a shipment of California salmon fry, an old gentleman who frequently visited the hatchery asked, "Who's going to stay down at the river to care for those minnows and chop liver for them?" The question at that time provoked a smile; but to-day, in all seriousness, I ask it of the advocates of fry planting. Who is to take care of your fry after they are planted? In this connection, it was well pointed out in the last meeting that the condition of the fry when planted was such that they must have food at once or they perish, while, on the other hand, the yearlings are in condition

to go without food for a considerable length of time. It has frequently happened in the past, and will I fear frequently happen in the future, that a plant of fry has been dumped in a stream at some point instead of being properly scattered in the smaller streams. Two of the best writers on trout-culture have hinted at the danger of this. In the "History of Howietoun," this significant passage occurs (page 69): "It must never be forgotten that fry of salmon and trout do not roam in search of food, but take up fixed positions, and snatch at particles carried past by the current; and they do not forage like yearlings until they are three or four months old. Many of the failures in fishculture are attributable to this habit being overlooked, although as early as 1873 it was noted by Livingston Stone, who says ("Domesticated Trout," page 171): "As they continue to grow, they increase their range, and by the first of September or a little later, they take their food like old trout." Now, what are the consequences of these fry thus taking up a fixed abode for several months? Unless the number be small or the food be unusually abundant, some of those which escape the thousand and one dangers of the fry stage will be stunted and never attain any size. But of the vast majority, what? They simply go to join the vast majority on the other side of trout life. Listen for a moment to a partial list of the destructive agencies which are waiting, watching and searching for them. But no, I won't inflict you. Their name is legion. You all know some of them, but none of us know them all. During the past four years we killed at Neosho Station 530 predatory birds, 239 piscivorous snakes, 2,500 lbs. of crayfish, besides very many other enemies. We try to exemplify the motto that "Eternal vigilance is the price of fish." And yet we lose young carp, tench, bass and other pond fish. Lose by the hundreds, yes, thousands. Not from disease or inherent weakness, but by enemies so insidious, so persistent, so minute, so numer-

ous, that we cannot totally eradicate them. Gentlemen, you will find it an enormous task to rear enough fry to counteract the destruction caused by natural enemies, and especially so unless all your plants are made under the best conditions, with the greatest care. You will find also that the cost of distribution when your fry are thus planted to the best advantage will commence to approximate the cost of distributing yearlings. Stocking a stream with yearling fish requires every degree of careful forethought; but stocking a stream with fry demands an intimate knowledge of the stream and its inhabitants, a more careful and wider distribution of the plant, and in many cases an accompanying or prior deposit of natural food adapted to infant trout diet.

In the Transactions of the Twenty-first Meeting of this Society, on page 113, occurs the following quotation: "I have seen it stated that in some of the streams of the Yellowstone, or West, several attempts were made to plant with fry, which failed, and other attempts made with yearlings succeeded. Now, the question naturally arises, suppose those yearlings do succeed and spawn there, what is to become of their fry when they are hatched? * * * It strikes me * * * if the fry cannot live in those streams, and nothing but yearling can, you have got to put in yearlings there every year." The foregoing remarks, no doubt, had reference to the plants of yearling trout made in the waters of the Yellowstone National Park by the United States Fish Commission in the autumns of 1889 and 1890, a concise history of which can be found in the Report of the United States Commissioner of Fish and Fisheries on the Explorations in Montana and Wyoming in the Summer of 1891 (Senate Mis. Doc. No. 65, pages 51, 52 and 53). I do not know the authority for saying these streams had hitherto been unsuccessfully tried with fry—though possibly they had. But I have the very best authority for saying that in at least one of these streams most unfavor-

able conditions prevailed for stocking with fry, and in one other the conditions were adverse for stocking with yearlings. One of the streams, the Upper Gibson River, contained the blob, or miller's thumb (*Cottus bairdi punctulatus*), and in the other, the Yellowstone River, the native mountain trout (*Salmo mykiss*) was abundant. The infernally destructive propensities of the miller's thumb are too well known to need remark here. The native trout of the Yellowstone has well been called voracious, and to him has been credited the destruction of at least one entire plant of fry. Prof. Everman, reporting on his reconnoissance of these waters, made in the summer of 1891, says: "At least the brook and Loch Leven trout, which were planted in 1889, spawned in 1890, as we found young of these species that could not be over a year old." Here is definite proof that yearlings planted in a stream are capable of reproducing and rearing their young, under conditions which would have, we may fairly say, been detrimental if not destructive to a plant of fry. How this was accomplished will, I think, show why it will not be necessary to annually restock a stream with yearlings because fry would not primarily live in it. That the trout do not exercise any direct parental care (one of the most potent and necessary factors in the reproductions of animals in general) I freely concede, and yet more freely that the young fry are under natural environment at all times the prey of numberless enemies. It is not asking too much to suppose that the yearlings would and do destroy, either as food or from self-protection, and in some cases from wantonness, very much of the animal life which would otherwise find a ready and acceptable subsistence upon the eggs and fry of the trout in the following year. It may be too much to state, but at least it cannot be contra-proved, that the adult trout destroys many of these enemies of their young from a sense of the necessity of the case. The yearling and the adult fish when planted in new waters in

their subsistence on its animal life, and in their fight for survival, in short, in their very living in these waters, prepare them for their progeny. It strikes me that in this they but parallel the only lines mankind has found practicable in colonizing new countries. The fact that a plant of trout fry in a particular stream, presenting outwardly all the conditions necessary for a happy trout life, has been barren of results should not be considered as conclusive argument that trout could not live and multiply in it. Try that stream again with enough yearlings sufficiently large to war upon the enemies of baby trout. And if the case is urgent, and the stream is worthy, try it with a few two or even three-year-old veterans. Take the case of the Yellowstone waters as an assurance that the fish will attend to their own multiplication and save you the trouble of annually replanting yearlings.

The relative values of fry and yearlings for stocking purposes will probably never be determined. It is certain that they both have their uses and advantages. There are times and places where fry can and will do all that is necessary for stocking a given body of water, and there are places where yearlings will be required to produce the desired result. For one, I am far from denying that very much of the magnificent result already achieved by fishculture is due to plants of fry. But, gentlemen, fry exclusively were planted when American fishculture was in its infancy; now that it has reached its majority it should stand ready to do a man's work of planting yearling fish where necessity demands, reserving its plants of fry for streams presenting favorable conditions of water and animal life. In this broad country of ours, with its diversified water systems and aquatic fauna, there are streams where fry planting will prove all sufficient, and others wherein only yearlings can succeed.

Food and cost of 28,000 rainbow trout raised at Neosho, Mo., Station, from fry to yearlings, on a mixed diet of

beef liver and mush, commencing when the fry were transferred to the outdoor pools, April 1, 1892, ending January 31, 1893:

| Period. | Daily Allowance. | | Total for the Month. | |
|---|---|---|---|---|
| | Lbs. of Liver. | Lbs. of Mush. | Lbs. of Liver. | Lbs. of Mush. |
| 30 days of April | 7.0 | 8.4 | 210.0 | 252.0 |
| 31 days of May | 7.0 | 8.4 | 127.0 | 260.4 |
| 30 days of June | 8.4 | 25.2 | 252.0 | 755.0 |
| 31 days of July | 8.3 | 35.0 | 195.3 | 1,085.0 |
| 31 days of August | 12.0 | 45.0 | 372.0 | 1,395.0 |
| 30 days of September | 12.0 | 60.0 | 360.0 | 1,800.0 |
| 31 days of October | 12.0 | 54.0 | 372.0 | 1,674.0 |
| 30 days of November | 12.0 | 60.0 | 360.0 | 1,800.0 |
| 31 days of December | 15.0 | 60.0 | 465.0 | 1,860.0 |
| 31 days of January | 15.0 | 60.0 | 465.0 | 1,860.0 |
| 306 days | ........ | ........... | 3,268.3 | 12,742.4 |

3,268.3 lbs. of liver, at 3½ cents a pound, cost ........ $114 39
12,742.4 lbs. of mush, at ¼ cent a pound, cost ........ 31 86

Cost of food for 28,000 rainbow trout, from April 1 to Jan. 31 ........ $146 25

Cost per 1,000, $5.22; or each fish cost a fraction over ½ cent. Average cost per day per 1,000 was 1.707 cents.

Average allowance per day per 1,000 was 1.87 lbs. of the mixture (in the proportion of 1 of liver to 3.79 of mush).

The fish were two sizes. On Feb. 11, 1893, they were measured, and weighed:

4,000 averaged 7 in. long, and 107.5 lbs. per 1,000, or 430 lbs. gross.
24,000 " 5½ " " " 42.5 " " 1,000, " 1,020 " "

28,000 yearlings weighed ........ 1,452 lbs. gross.

A cost per pound of a fraction over 10 cents.

Food and cost of 12,000 "vegetarian" rainbow trout raised at Neosho (Mo.) Station, from fry to yearlings, commencing when the fry was transferred to the outdoor pools, April 1, 1892, and ending Jan. 31, 1893.

| PERIOD. | Daily Allowance. | | Total for the Month. | |
|---|---|---|---|---|
| | Lbs. of Liver. | Lbs. of Mush. | Lbs. of Liver. | Lbs. of Mush. |
| 30 days of April............ | 3.0 | 3.6 | 90.0 | 108.0 |
| 31 days of May............ | 3.0 | 3.6 | 93.0 | 111.6 |
| 30 days of June ............ | 3.6 | 10.8 | 108.0 | 324.0 |
| 31 days of July............ | 2.7 | 15.0 | 83.7 | 465.0 |
| 31 days of August.......... | .... | 45.0 | .... | 1,395.0 |
| 30 days of September........ | .... | 45.0 | .... | 1,350.0 |
| 31 days of October.......... | .... | 45.0 | .... | 1,395.0 |
| 30 days of November....... | ... | 45.0 | .... | 1,350.0 |
| 31 days of December........ | .... | 45.0 | .... | 1,395.0 |
| 31 days of January ......... | .... | 45.0 | .... | 1,395.0 |
| 306 days.................. | ........... | .......... | 374.7 | 9,288.6 |

374.7 lbs. of liver, at 3½ cents a pound, cost........................$13 11
9,288.6 lbs. of mush, at ¼ cent a pound, cost.... .................... 23 22

Cost of food for 12,000 rainbow trout, from April 1, to Jan. 31.........$36 33

Cost per 1,000 $3.03; or each fish cost a fraction under ⅓ cent. February 11, 1893, they were measured and weighed: 12,000 averaged 4 in. long, and 27.5 lbs. per 1,000, or 330 lbs. gross. A cost per pound of about 11 cents.

NEOSHO STATION, FEBRUARY 11, 1893.

*Measure and weight of yearling rainbow trout.*

100 of the largest, mush and liver fed, 10.75 lbs ........7 in. long.
100 medium size, " " " " 4.25 lbs..........5.5 in. long.
100 of those fed on mush only 2.75 lbs..........4 in. long.

NEOSHO STATION, FEBRUARY 11, 1893.

*Measure and weight of yearling brook trout.*

100 average size, fed on mush and liver, 7.5 lbs..........6.5 in. long.

NEOSHO STATION, JUNE 5, 1893.

*Size and allowance of three-year-old rainbow trout.*

1,000 three-year-old trout in Pond No. 1 are supported in perfect condition on 2 lbs. of liver and 40 lbs. of mush per day.

10 of the largest weigh...................................17.5 lbs.
15 of the medium weigh....................................19.5 lbs.

25 of the three-year-olds weigh...........................37.0 lbs.

or each fish 23.68 oz., making the weight of the 1,000, 1,480 lbs. The allowance per day is less than 3% of their weight of the mixture (in proportion of 1 of liver to 20 of mush), costing now 19 cents per day.

FEEDING AND GROWTH OF RAINBOW TROUT IN THEIR SECOND YEAR.

February 20, 1893, counted 1,500 13-months-old extra select rainbow trout into Pond No. 2 to be raised for future brood stock. Total weight, 140.5 lbs., an average of 93.67 lbs. per 1,000. Average length of trout, 7 in.

April 26, 1893 (65 days afterward), these trout were reweighed and found to average 260 lbs. per 1,000, and to measure from 8 to 9 in., being an increase in weight of 178 per cent. During these 65 days they had been given 185 lbs. of liver and 1,008 lbs. of mush, costing $9.29, or each pound of trout gained (after February 20) cost a fraction over $3\frac{3}{8}$ cents.

May 20, 1893, 90 days after the fish were first put into No. 2 Pond, they were again reweighed and found to average 320 lbs. to the 1,000 fish, and to run from 9 to $9\frac{1}{2}$ in. long, being an increase in weight of about 241 per cent. During these 90 days they had been given 305 lbs. of liver and 1,627 lbs. of mush, costing $17.01; or each pound of trout gained (after February 20) cost a fraction over 5 cents.

N. B.—Prior to April 1, 1893, liver cost $3\frac{1}{2}$ cents a pound, after that the price was $4\frac{1}{2}$ cents a pound. The cost of mush remained unchanged, namely, one-quarter of a cent a pound.

Up to the time these fish were transferred to Pond No. 2, they had been all the time in a pool 8 x 22 ft., among a lot of 6,000 other yearlings. The element of range, so essential to the growth of fish, was entirely lacking, as was also that of space and natural pasturage. Pond No. 2, into which they were transferred, supplied to a certain extent these requisites. It has a water surface of about 6,000 square feet and a greatest depth of 36 in. Whereas the pools had a greatest depth of only 2 ft., wooden sides and bottom, and with a constant change of 55 gallons of water per minute, the maintenance of pasture under these condi-

tions being impossible. Pond No. 2 is, for at least one-quarter of its area, less than 6 in. in depth, containing considerable aquatic flora and breeding no little natural food.

NEOSHO, MO., JAN. 25, 1892.

*Specimens of trout shipped from Neosho to Washington, D. C., Jan. 25, 1892, to be cast for the World's Fair.*

No. 1. Male fish, rainbow trout, hatched from eggs received from Wytheville Station in January, 1890. Weight, 30 oz.; age, 2 years.

No. 2. Same as No. 1. Weight, 21 oz.

No. 3. Brook trout, hatched from eggs received from Northville Station, January 25, 1891. Weight, 6 oz.; age, 12 months.

No. 4. Same as No. 3. Weight, 6.5 oz.

No. 5. Von Behr trout (*S. fario*), hatched from eggs received from Northville Station February 5, 1891. Weight, 3.5 oz.; age, 11 months.

No. 6. Same as No. 5. Weight, 3.5 oz.

No. 7. Rainbow trout, hatched from eggs received from Wytheville Station, January 17, 1891. Weight, 3 oz.; age, 12 months.

No. 8. Same as No. 7. Weight, 1.5 oz.

DISCUSSION UPON MR. PAGE'S PAPER.

MR. MATHER—I did not take any notes during the reading of Mr. Page's paper, except some mental ones. I rather expected to hear from Mr. Clark upon this subject, and I wanted him to get up and say something. Dr. Cary said that there would be no fun unless Mr. Clark and I had our little sparring match.

One thing, however, occurred to me during the reading of the paper, and that was, that if we stock a stream with yearlings and those yearlings breed in that stream, and their fry succeed in making a living of it, why would not the fry which might be introduced from the hatcheries

live there just as well? If fry will not live in that stream, that are artificially hatched, why should they live when they are the offspring of those yearling fish?

They are claiming a great deal of success in planting yearlings, although it has not been a great many years yet since that theory was sprung upon us. At our last meeting, when I read my paper, there was considerable discussion upon it, and four or five gentlemen took ground against me, stating there was no need of planting fry, for instance, Mr. Roland Redmond. He said one thing in favor of the yearlings was that you didn't have to transport them; all you had to do was to open the gate and let them swim out. But suppose we take the State of New York, which has considerable territory, and suppose we attempt to raise our fry to a yearling age—and Mr. Page has skipped the transportation question entirely—and we send off men one hundred and fifty to two hundred miles with fish, fifty trout in each can. If we send them with yearlings, it will depend upon the size of your yearlings whether there are twenty or thirty or more in a can, and they could only take at most three hundred of those yearling fish; and it would cost about all the money the New York Fish Commission has got to transport her trout if they raised them to be yearlings.

Here is a letter that was written to me last summer that bears upon this subject. It is from Raymond E. Wilson, Secretary of the Board of Fish Commissioners of the State of California. I had had some correspondence with him before upon the same subject, and this is his letter:

BOARD OF FISH COMMISSIONERS FOR THE
STATE OF CALIFORNIA.
SAN FRANCISCO, CAL., July 28, 1892.

MR. FRED MATHER,
*Cold Spring Harbor, Suffolk Co., New York:*

MY DEAR SIR: I beg to acknowledge yours of the 22d inst., and thank you for the same.

I am aware of the fact that the United States Fish Commission are advo-

cating the planting of yearling trout. We have not made the attempt, and cannot do it. Our regular appropriation in our hatchery fund is only $5,000 annually. This amount is probably swelled during the year by about $1,500 from fines and licenses. Out of this fund we hatch and distribute yearly nearly or quite 3,000,000 salmon, which takes about one-half of the fund.

The expense of distribution with us is a serious matter, as nearly all of our planting has to be done at a considerable distance from points on railroad. For illustration, we start this week with one shipment of say 25,000 fish for a point on the east side of the Sierras, distant some eighteen hours by rail from hatchery, and then between fifty and sixty miles by wagon. I do not hesitate to say that on the score of expense the planting of yearling fish in our State is impracticable and wholly out of the question. This spring we made an experiment with the *fontinalis*, and kept them until they were five months old before planting. We will not do it again, as we cannot afford it, and, besides, the planting of the older fish was not as successful as that of the younger. We have now commenced the distribution of our rainbow. They are three months old, and plenty large enough.

The Fish Commissioner of Nevada, Hon. Geo. T. Mills, is the only one whom I have heard of who has made a success of raising and planting yearlings, but he does this under most extraordinary favorable circumstances. His hatchery is located in Carson City, perhaps five or six blocks from the railroad depot. When his fish are say three months old, he transports them by rail to the Truckee River and plants them in a large pond formerly used as an ice pond, having direct communication with the river. Here he keeps them for a year, feeding them in the meantime, and when the time comes he opens connection with the river, and the fish distribute themselves. He does the same with the land-locked salmon. To a certain extent, we are doing the same thing this year with our salmon. We have made a large nursery pond at our Sisson Station, which has connection with tributaries of the Sacramento. We keep them until the ice begins to form, and then let them out into the stream. To undertake to raise and plant yearling fish in any other manner would require a very much larger appropriation than we have.

Yours very truly,

RAMON E. WILSON,
*Secretary.*

During the reading of the letter, Mr. Clark interrupted the reading, saying:

MR. CLARK—Let me break in here. Let me say right there that I was the father of this idea, and not the Commissioner, and don't say he orders it.

MR. MATHER—You recommend it, he orders it. I know it was your first suggestion. I thought I would get him up after a while.

Mr. Mather then finished the reading of the letter.

Mr. Mather—There were several things I desired to say, but I will leave them until after we hear Mr. Clark.

Mr. Clark—In the discussion of this question, I hope one thing will not be done—don't let us be too personal. This is a question, as I said last year and two years ago, that I consider vital to fishculture, the question of planting fish right. That to-day, in my mind, is all there is to learn in fishculture. The matter of getting eggs and hatching them is a thing that is just as simple in practice as the manufacture of skirts.

Our worthy President to-day touched upon a subject that is very important, the question of the food of the fishes. It is one of the very important questions. The planting of fish, not only in the right place where the food is, but the question of planting as near as you can the right kind of fish for the water, is equally important.

The writer of the letter which Mr. Mather has just read states that their Commission cannot raise yearlings, but he also tells us what they are doing in that line. They have their nursery where they keep them until a year old, and then let them run into streams; and that is what I have been advocating for a number of years. We raise them at our hatcheries because we have to do it. If it were possible to do it in every instance, and you had a nursery at the head of every stream you stock, it would be better to have it right there. We have one instance of this kind of work in Michigan, where they have commenced just such an enterprise, and Commissioners Post and Whitaker have visited it, and know that what I say is the fact. They have a little nursery, and they propose to plant their fry there where they feed upon natural food. This is just what I have been advocating all along—protect your fry. I don't mean to hatch five million trout fry in this way, because it is impossible to do it unless you have lots of money. At Northville we handle four million trout

eggs, but we don't undertake to raise four million fry, but I do raise two or three hundred thousand fry to be yearlings. I am really glad that gentlemen take these things up and discuss them. But the point is to protect your fish. You take one hundred thousand fry and plant them in a stream, put them right in where there are other fish, and a great many of them will be eaten up. That we know. Of course, if you plant fry as Michigan, Wisconsin and New York have done, you are doing a great work. I have never said that these States have not done a great work in planting trout fry, because they have. I brought here last night evidences of what the Michigan Fish Commission have done, both in rainbow trout and other fish; but I hope they will never put a trout in a grayling river in the State of Michigan or in any other State. Now, what I say is this. Protect the fry and keep them from the other fishes by raising them at the hatcheries, if that is the best you can do, or by having rearing pools at the head of the stream or wherever you can.

Mr. Mather—We will fight it out fairly now. This letter says, "Speaking of * * * * to a certain extent we are doing the same this year." But he does not have to transport them, he hatches them right there.

Mr. Clark—Yes, but he could transport the fry all right.

Mr. Mather—Mr. Clark and Mr. Page have skipped the question of transportation. Mr. Page did not touch at all on the transportation of the fish. It is going to take a great deal of money to do it, and a great deal of the time of the men to do it, and I believe you can hatch fish in quantities large enough to overcome all casualties by death, and I say just put them in in plenty, and at a small cost comparatively.

Mr. Page raised the question of who would take care of these fish. Well, the Lord provides for their care if there is any food in your streams, and they will scatter and find

it. If there is no food, it is not a proper stream to stock.

Another point that Mr. Page quoted, I think from Mr. Livingstone Stone, that there was no need of loss of any account in trout fry. All of us who have had very much to do with brook trout fry for any number of years have seen in a batch of trout eggs some little fellows that will just break the egg to die; others will hatch and carry along until the time comes to take food, and then they die because they cannot assimilate the artificial food. I do not think a man can take one hundred thousand trout eggs and raise one hundred thousand trout out of them. If you have a certain number of eggs of chickens, or calves or babies, you are going to lose some of them sure.

Mr. Page—I think I could not have made myself very clear, when he says I didn't touch the question of expense at all.

Mr. Mather—The question of transportation.

Mr. Page—All these questions of expense in this work, where it is done by the State or Government, are questions that I don't think cut any figure in the question under discussion, so far as you or I are concerned. They are matters of consideration for our superior officers and the legislatures who order us to do the work.

But I did touch upon the question of transportation when I told you that if your trout fry were distributed under the best conditions, with a full knowledge of our streams, your expense of distributing fry would approximate the expense of distributing yearlings. You are mistaken if you think that was the case. But the trouble is that the fry take up a fixed abode; they huddle up in one place, and they stay there for three or four months, just waiting for a snake to come along and take them in. One other point. Did I understand you that only twenty or thirty yearlings could be carried in a can on an average in the transportation season?

Mr. Mather—If you are going any distance.

Mr. Page—We are averaging of yearlings, twelve months old fish, and we raise them as large as anybody in the world, from sixty to one hundred fish in the ordinary round can——

Mr. Mather—How many gallons?

Mr. Page—That same old can.

Mr. Mather—How far do you carry them?

Mr. Page—Some up in Minnesota and some away South.

Mr. Clark—I will say that I took 1,060 year old lake trout to Washington, and they were in ten cans, and I landed them in Washington with just 1,010 fish; and they were carried in an old-fashioned baggage car. The matter of expense in transportation, it seems to me, to-day with most of the State Commissions, as well as with the United States Commission, as they are carried in our cars, is very slight. We receive free transportation over most of the railroads, and I don't think that should be taken very much into consideration.

I think your letter from California stated that they had five thousand dollars for their hatchery. Now, you take the most of your State hatcheries, and suppose you don't have but five thousand dollars for your hatchery, and you handle from two to four millions of eggs, and that includes your superintendent's salary—that is about the way they run. The superintendent can with that much money raise from 175,000 to 200,000 yearlings, in addition to his regular trout work. I have got the figures to show that, too.

Mr. Post—I have been very much interested in the paper of Mr. Page, and it has thrown some light upon the subject, probably, of the better way of feeding and raising fry to yearlings. It is very interesting in that respect, and is the result of actual experiment, which ought to be correct.

The aspect which the case now assumes, however, is quite a different one from what it appeared to be two years ago and a year ago. Then it was yearlings versus fry,

now it seems to be a combination of the two. That is quite a different thing. Of course, those of us who have known, and that, of course, includes all who have had anything to do with the work of the different States, of the remarkable success in all the States of the planting of the fry of the brook trout, would resent the idea of giving up the planting of fry and taking up the planting of yearlings in their place, because it would be putting something in the way of experiment in the place of success. Now that is not advocated by either of the gentlemen to-day, and probably we will get around finally on to ground where we can all agree. The idea of raising two or three hundred thousand yearlings out of two or three million fry is not a question of fry versus fingerlings ; it is a matter simply of diverting a part of your fund for raising or hatching fry into the transportation of yearlings.

It may be that there is a great deal of truth about what Mr. Page has said about there being places where yearlings will do better than fry, but the problem of cost confronts every one of the State Commissioners, which Mr. Page says they leave to their superior officer, and which he says we should leave to the Legislature. We go to the Legislature to get all the money from the Legislature we can. The problem with us is how to spend that money to get the greatest results. If with the small appropriations we get we are going to get the very best result from fry planting, and our work shows it, we shall be able to get from our Legislature larger and larger appropriations to increase the work we can do. So, when it came to be discussed heretofore whether we should change from old methods which had produced great results from small expenditures to a thing which was an experiment, we were taken by surprise. But the question as it has been discussed to-day is quite a different thing.

Mr. Clark—I don't know but I am on my feet more than I am entitled to be, but that is just the shape of the

thing. That is where it should have started in two or three years ago. You will not find me quoted, neither in any paper, nor in any argument, nor anywhere else, as advocating the stopping of the planting of fry entirely and going to raise yearlings—not at all.

Mr. Page—Me too, please.

Mr. Clark—I have never advocated it at all, because the United States Fish Commission is not doing it anywhere, and the point is right there. We are to-day beginning to understand ourselves, as Mr. Post has stated. I never presented a paper on Fingerlings versus Fry, and I don't think our worthy Secretary will find the original headed in any such way.

Mr. Post—It got into the report that way.

Mr. Clark—And I want it understood that I have advocated the rearing of fish and the planting of larger fish, in a measure, instead of all fry.

Secretary—The title of your paper was "Rearing Fish for Distribution."

Mr. Vincent—Mr. President, I am trying to get something out of this discussion to-day. It is new to me largely. The State of Ohio, which I represent, has been hatching fish largely for years, but it has been mainly for the lakes, and we are endeavoring now to get them into the small streams of the State. The question of the transportation of these fish after they were yearlings was spoken of by the gentleman who just took his seat. I will say that in our State we have largely free transportation, but it does not seem to me that that factor need to come into it very largely. We have to distribute the fry in that manner, but if the plan is more practical is what I want to know, to rear your fish for a time in intermediate waters; that is what I want to find out. We can have those intermediate points on the streams we wish to stock, and we have already undertaken to establish one or two of those

places; and if that is the case, the matter of transportation will not come in.

Mr. Post—How would you do with two or three thousand streams? Would you have points on all of them?

Mr. Vincent—As I understand, the fish will distribute themselves over a large area if they have the opportunity. We perhaps have five or six rivers which reach the Ohio River, and their tributaries taking in perhaps two-thirds of the State, the Scioto, the Hocking, the Muskingum and the Little Muskingum, which reach up to within thirty miles of the lake. The question I want to get at is whether it is more practical to turn the fish into the rivers after six months of age or to put them in when they are fry.

Mr. Mather—I would just like to ask Mr. Clark one little question; that is, if it is better to plant your fish as yearlings, why do you not advocate the planting of them all as yearlings, if that is the best plan?

Mr. Clark—One great trouble with that is that if you undertook to raise five millions of fish, it would be a very great expense.

Mr. Mather—That is the point.

Mr. Clark—Now hold on, hold on; but we can raise from two to four hundred thousand at a hatchery with a very slight additional expense. Why? Because you are going on with your regular work, and you have to have your regular men, and your regular men can do this work of caring for the fish during the fry stage. You take five million, and, of course, you have to hire some additional help, and you have to be to some additional expense; but it may be, in the course of human events, after we get this question around, as it comes around now, that we will advocate the raising of them all. Of course, that would be quite an additional expense. Of course, in regard to the yearling question, our arguments have all been on trout. Now, I advocate the handling and rearing of whitefish in the same manner. Have a rearing

pond at some good point; for instance, in Michigan we might get near some good lake which we think would be adapted to them, and have our nursery and keep those fish by themselves, where no enemies could take them, and then let them out in the lake afterwards.

Mr. Page—Upon the tendency young trout have to settle in one place after being planted, I want to say they don't scatter or roam about in search of food for a considerable length of time after they have absorbed their food sac. They huddle up in one spot, and any one knows who has paid any attention to it that their enemies are legion. I would be afraid to state now from memory how many snakes, destructive birds, lizards, etc., we have killed at Neosho Station; but we killed in three months last fall twenty-five hundred pounds of crayfish; and as for snakes, I killed one day in a pool a snake, and when opened we found he had taken twenty young brook trout.

# STATISTICAL REVIEW OF FISHCULTURE IN EUROPE AND NORTH AMERICA.

BY N. BORODINE,

Delegate of the Russian Association of Pisciculture and Fisheries.

International exhibitions give a good opportunity to reckon up the work done in different branches of human activity, and I thought it opportune to do the same thing with regard to the most recent industry—fishculture.

During the last two years I have made a special study of fishculture outside of my country, and visited many hatcheries of importance in Europe and North America. I was thus enabled to collect some material, which is summarized in the following short review. The figures of North America were taken from the reports of the United States Fish Commission, State Fish Commissions, annual reports of the Ministry of Marine and Fisheries of the Dominion of Canada, and from the report of the Superintendent of Fisheries of Newfoundland. Those reports, regularly issued, are uniform, but they do not include any information about private fish hatcheries. For Europe, the figures have been taken from scattered information in special literature, from official information furnished by the respective Governments, and private information from the proprietors of fish hatcheries which I visited personally.

I do not consider the following figures as absolutely exact; on the contrary, I am sure that one of them, for want of regular reports, are less than reality. Nevertheless, I believe that a review of figures already known upon this matter may have some interest. Concluding these introductory remarks, I ought to say that I do not deal in this paper with pond culture, the only object of comparison being the hatching of fish in the establishments specially constructed for that purpose.

The following table gives an idea of the number of fish

hatched (in one season) in different countries of North America and Europe, indicating the date of information, the number of fish hatcheries and the expenses of the Government for fishculture:

| | Date of information. | Number of fish hatcheries. | Number of fish hatched, millions. | Annual appropriation for fishculture. |
|---|---|---|---|---|
| NORTH AMERICA. | | | | |
| United States: | | | | |
| State fish hatcheries | 1882–92 | 46 | 416. | $174,040.00 |
| U. S. Fish Commission | 1891–92 | 20 | 491.2 | 150,000.00 |
| Total U. S. | | 66 | 907.2 | $324,040.00 |
| Dominion of Canada | 1890–91 | 13 | 128. | 39,496.50 |
| Newfoundland | 1890–91 | 1 | 581. | 6,100.00 |
| Total N. A. | | 80 | 1,616.2 | $369,636.50 |
| EUROPE. | | | | |
| Norway | 1890 | 58 | 214.5 | 4,166.50 |
| Germany | 1891 | 90 | 25.5 | 21,815.00 |
| Switzerland | 1890 | 84 | 13.7 | 2,207.00 |
| Great Britain | 1891 | 16 | 8.6 | ...... |
| Sweden | 1891 | 34 | 5.4 | ...... |
| France | 1891 | 17 | 4.2 | 3,960.00 |
| Austria-Hungary | 1891 | 96 | 2.8 | ...... |
| Italy | 1891 | 5 | 1.1 | ...... |
| Netherlands | 1891 | 2 | 1. | 2,084.00 |
| Russia | 1891 | 14 | 1. | 2,800.00 |
| Total of Europe | | 416 | 277.8 | $37,032.50 |
| Grand total | 1891 | 496 | 1,894. | $406,669.00 |

The most of the figures relate to 1891, so that we are able to consider the grand total for this year. On the other hand, all the principal countries being included in the table, we may estimate this total as representing the figures of fishculture in the entire world. Four hundred and ninety-six fish hatcheries are registered in this record, 416 of them in Europe and 80 in this country.

The fish hatcheries of North America, included in the table, belong, without exception, to the respective Governments.

Most of the European fish hatcheries are private establishments, and only 82 out of 416 are controlled by their respective Governments, viz., 14 in Switzerland, 1 in Germany, 5 in France, 2 in Italy, 58 in Norway, 1 in Great Britain and 1 in Russia.

The totals of fish hatched in North America (1,616,027,-192) as compared with Europe (277,973,016) show that only about 14 per cent. are produced in Europe; among European countries, only Norway, thanks to the active part taken by its Government, can be considered as a serious competitor of the countries of the new world. The average production of one fish hatchery is 668 thousands in Europe and 13.4 millions in North America. Such a striking difference of the new world depends principally upon the difference in the character of the hatcheries of both continents. As before mentioned, the European fish hatcheries being private establishments, do not pursue the task of restocking public streams, but only the streams belonging to the proprietors, and very often they produce fry for sale to other proprietors of fish ponds, etc. Another circumstance to be mentioned in connection with the small size of European establishments is that no hatcheries—or very few—exist here for hatching of *Clupeidæ*, *Percidæ* and salt water fish; the hatching of these kinds of fish, to be successful, ought to be carried on on a large scale. The last and the most important question is the financial one. While the Government of the United States, of different States, of the Dominion of Canada, grant very considerable amounts of money for fishculture, and take direct interest in this work, in Europe, with the exception of Norway, Germany and Switzerland, the respective Governments do not pay much attention to it.

The Government of the United States has a very important bureau, known as the United States Fish Commission, with annual appropriations of $298,000, viz.: $150,000 for propagation of fish, $50,000 for distribution, $53,000 for

maintaining vessels, $5,000 compensation of Commissioner, and $20,000 for scientific investigations and statistical work. Besides this regular budget, the United States Fish Commission receives for extraordinary expenses, as, for instance, the construction of new hatcheries, new vessels, fish cars, etc., a considerable amount of money.

The Governments of separate States compete in usefulness of this work with the Federal Government, making large appropriations for building hatcheries and distributing fish. I must particularly mention the State of New York, with a yearly appropriation of $34,000, the State of Michigan, with an appropriation of $22,500, and the State of Pennsylvania, with a grant of $15,000. The total amount of money granted for fishcultural work by all the States is equal to $169,040 (1891).* The present appropriations are likely to be increased, because in very many reports I have examined, the Fish Commissioners were asking for a larger amount of money.

The Government of the Dominion of Canada has been for a long time actively engaged in the propagation of fish. The expenditure for this work was in 1891 $374,202, which includes $39,496 for fish breeding and $83,050 for fish propagation.

The Newfoundland Government works also quite successfully with an appropriation of $17,300, that is, $6,100 for fishculture and the remainder for fish propagation and fishery administration.

In Europe, Germany expends the largest amount of money for fishculture work, say $21,815, which includes $12,500 of subsidy to the Deutsche Fischerei Verein, the leading association of its kind in Europe, and $9,315 for the Government fish hatchery in Hüningen. Many private hatcheries exist in that country, thanks to the orders for hatched fry given by the above association, which has no

* General expenses of same States for fish protection and carp culture are not included in this total.

hatchery of its own. The Hüningen fish hatchery—perhaps the largest on the continent—has no value from the standpoint of the modern fishculturist, and with regard to the accommodation for the work, many private establishments* in Germany leave far behind this big, but inconvenient, old-fashioned hatchery, which, I think, has completed its historical role in fishculture. Norway is now one of the leading countries in regard to the work for all kinds of improvements in fisheries. Its Government grants for this purpose an amount of $57,788 yearly, which includes $41,665 for fishculture in particular.† One of the largest salt-water fish hatcheries in the world, at Flodevigen, near Arendal (200,000,000 cod fry hatched in 1891), is controlled by a local fishery association, and gets a subsidy of 9,000 kroners from the Government. Next comes Switzerland, which operates, as compared with its area, on a very large scale. The Federal Government of that country has an appropriation of $2,207 for the fry planted by private men in the public waters. Besides that, almost every canton has one, two and sometimes several cantonal fish hatcheries.

France—the cradle of pisciculture, the country which has contributed toward the development of this new industry more work than any other country—now ranks far behind many European countries. The French Government does not pay much attention to fishculture in general, having an appropriation of 19,860 francs ($3,972) to maintain five not very large governmental fish hatcheries, and subsidize a private one (for shad hatching at St. Pierre les Elbeuf, on the Seine River). Only quite recently, thanks to the statements made by the Société Centrale d'Aquiculture de la France, the attention of the French

*I can mention here the well-situated and nicely-fitted fish hatcheries in Selzenhof, near Freiburg (8,000,000 trout eggs capacity), and in Seewiese, near Gemunden, Bavaria (4,000,000 capacity).

†The total of 208,040kr. is thus distributed: For scientific investigation in fisheries, 5,200kr.; subsidy to the fishery associations, 45,000kr. (that includes 8,000kr. for the hatchery at Flodevigen): maintenance of fishery schools in Bergen and Bodo, 11,500kr.; fishculture work, 7,250kr.; and the remainder for fish protection and fish administration.

Government has been called to fishculture work, and I am informed that negotiations are being made to establish a special fishculturist school at the Gremaz fish hatchery, which belongs to M. Lugrin, inventor of the method of propagating artificially live food for fish fry.

Italy has only recently begun fishcultural work under the control of the Government, which has appropriated 32,000 liras ($6,500) for the construction of a large fish hatchery at Brescia, now in operation, and has opened another small one at Rome.

The Netherlands Government appropriates only 5,000 gulden ($2,084) for the salmon fry planted in the Rhine River. No appropriation is made by the Austria-Hungary Government, the fishculture work being carried on by private initiative of landlords and associations.

The same remarks must be made in regard to Great Britain, with the single exception of Scotland, the fishery board of which erected last summer a salt-water fish hatchery at Dunbar; no special appropriation was made for this purpose, the expenses having been covered by money assigned for scientific investigation (£1,800 yearly).

The Swedish Government contributes to some extent to the improvement of the fishery industries in its country, having a yearly appropriation of 47,000 kr. ($13,155), but that does not include any expense of fishculture work in particular.

And finally Russia has an appropriation of $2,800, which is, in comparison with its area, quite insignificant. That includes 3,000 roubles for maintaining one governmental fish hatchery at Nicholsk, Government of Novgorod, which was founded by the well-known Russian fishculturist, Mr. Vladimir Wrasky, the inventor of the so-called Russian or dry method of impregnation, and 5,000 Finnish marks of subsidy to the Fishery Society of Finland.

When we compare the total amount of money spent for fishculture work by all European countries ($37,032.50)

with the appropriations of North American countries ($369,636.50), we shall not be surprised by the enormous difference in the work done in this line in the Old and New World. Of course, that is only an explanation of the fact, but not an eulogy.

Europe has originated and developed the methods of fishculture, but it becomes an industry only in America, and a very important one, from the standpoint of the Government. Only here is fishculture carried on on a large industrial scale, and, in connection with it, here are invented and introduced in general practice, methods suitable for large operations, quite different from those used in Europe.

There is no better testimony of the importance of fish-cultural work than the large appropriations made by the body of representatives of the country, and only in North America is this work duly appreciated by the Government as well as most of the population.

### DISCUSSION OF DR. NICHOLAS BORODINE'S PAPER.

Mr. Clark—I would like to have the Doctor tell us what they are doing in France about raising artificial food, where they state they grow the food in such enormous quantities. I understand he has been there.

Dr. Borodine—It has been a secret until now, but from what I have seen I am sure it is a very important thing.

Capt. Collins—The Doctor made reference to the large number of lobsters hatched in Newfoundland, and I thought perhaps the Society might be somewhat interested in this matter as bearing upon the paper read yesterday. It may not perhaps be known by all the members of the Society that Newfoundland authorities have put in boxes at many harbors where fishermen or some person connected with their Commission obtained the eggs, and putting them in these floating boxes, leave them there to hatch

out. This accounts for what seems to be an enormous output with very small expenditures. I am personally familiar with the coast down there and know they have opportunities for doing this which are unexcelled, if they are equalled, in the world. However, the fact that they do this seems to offer a useful suggestion to those who are engaged in the propagation of marine species in the United States—a suggestion which I hope will prove profitable not alone to those engaged in fishculture, but to the fishermen themselves.

Mr. Booth—It seems to me, Mr. President, that with the consent of the Doctor, these statistics should be obtained from him and printed and kept for the benefit of this Society. To me it has been a very remarkable paper, and a very interesting one and very valuable. I would suggest, with the Doctor's consent, that we have it in the records.

The President—I will say for the information of Mr. Booth that all papers read before the Society have heretofore been printed, and this paper will follow the same course, if there is no objection on the part of the Doctor.

Capt. Collins—Mr. President, I have a paper here which has been handed to me by the Hon. Mr. Ravn, Commissioner of Norway to the Columbian Exposition, which he has requested me to read. It has been prepared for the purpose of showing something regarding the Norwegian exhibit, or rather making allusion to it, and at the same time to give a comprehensive idea, in a few words, of the extent and value of the Norwegian fisheries.

I will say, as a prefatory remark, that Norway occupies in the Fisheries Building the largest space of any foreign country, and its exhibit is perhaps more complete than that of any other country with a collection there.

I shall have much pleasure to-morrow afternoon, if I can have an opportunity, of calling the attention of the Society specifically to certain things in the Norwegian section that

I deem worthy of notice. I think it is a matter of congratulation and satisfaction to all interested in American fisheries that the Europeans have done so well in sending exhibits here. I regret to say, however, that all have not arrived yet. Germany at first declined to make an exhibit of this character, but later on its Commission decided that it would be a good thing to do, and I now understand there is a large collection on the way from Germany, which may be expected here in a few days.

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## SOME PLANKTON ESTIMATES IN THE GREAT LAKES.

BY J. E. REIGHARD.

In 1881, Prof. S. A. Forbes conducted at Chicago some experiments to determine the first food of the common white-fish. The details may be found in his paper,* so that it is sufficient here to recall his conclusion, that the young white-fish takes as its first food certain minute entomostraca found swimming freely in the open water (*Cyclops thomasi* and *Diaptomus sicilus*).

Forbes pointed out, moreover, the importance of determining the presence and abundance of these entomostraca in any locality in which it is proposed to plant white-fish fry. In spite of this advice, nothing appears to have been done in the ten years that have passed since the publication of Forbes's paper.

Fishculturists have annually planted millions of white-fish fry without taking the trouble to determine whether the waters in which they place them contain the necessary food in sufficient quantity. There is urgently needed an

* The First Food of the Common White-fish, Bulletin No. 6, Illinois State Laboratory of Natural History, May, 1883.

exact knowledge of the numbers of these minute crustacea in a given volume of water, over the whole area of the great lakes, and at each season of the year; and not until such determinations have been made will the fishculturist know accurately where his fry may be most advantageously planted.

In April of this year, the Michigan Fish Commission requested me to make an examination of the waters in which the white-fish fry were at that time being planted. As the planting operations had already begun, only a short time remained in which to make preparation for the work contemplated, so that it was not possible to have apparatus of precision made for the purpose.

The only entirely accurate method of determining the volume of living forms (*i. e.*, the *plankton*) contained in a given volume of water is by the use of the vertical plankton-net. This is a conical net of fine silk bolting-cloth attached to a metal ring. It is lowered to the bottom and then drawn slowly upward to the surface. The net thus strains the water in a vertical column, the base of which is equal to the size of the opening of the net, while its height is equal to the distance through which the net is drawn in raising it. Not quite the whole of this column of water is thus strained through the net, since the resistance offered by the meshes of the cloth causes about one-tenth of it to pass over the edge of the net. Whatever was contained in the column of water strained is found at the bottom of the net, and may be preserved in alcohol for future examination. After the material has been brought to the laboratory, the volume taken at each haul is measured by means of graduated glass tubes reading to tenths of a centimetre. This volume is that of all the minute animals and plants living under an area of lake surface equal to that of the opening of the net. From this it is possible to compute the volume of minute living forms to be found over any given area of water or in the entire

lake. By the use of suitable devices it is possible to count the number of individuals of any kind contained in a measured volume of this material, and from such a count we may estimate the exact number of hundreds of *Cyclops*, or of any other form contained in every cubic yard of the water. Thus we may estimate the number of individuals of any kind in an entire lake.

As there was not at hand the apparatus necessary for working with the vertical plankton-net, recourse was had to an ordinary muslin tow-net, about one foot in diameter and three feet deep. Since the quantity of material to be obtained by raising this net from the bottom to the surface was exceedingly small, serious errors were likely to be introduced into the measurements by the losses incident to emptying the net and getting the material into the preserving bottles. Instead of using the net as a vertical net, it was, therefore, towed behind the boat for a certain number of minutes and then emptied. The amount of material thus obtained was much greater than by using the net as a vertical net, and the losses incident to emptying were relatively so small that they could be neglected. The net was towed sometimes at the surface, while at other times it was weighted so that it traveled beneath the surface. When the net was out of sight beneath the surface, the angle made by the tow-line was measured with a goniometer, and from this measurement and the length of the line was calculated the distance of the net beneath the surface.

The net was usually towed behind a tug for ten minutes. Occasionally the time was twenty minutes and sometimes only five minutes, but all calculations have been reduced to a basis of ten minutes. The boat was estimated to travel at the rate of one mile per hour. For this nothing better was to be had than the statement of her captain, so that there may be a considerable error in this respect, but it is a uniform error which does not affect relative values. In

ten minutes the boat would thus have traveled 880 feet. The area of the opening of the net is 100 square inches, or .75 of a square foot. In ten minutes the net thus strained 880 x .75 = 660 cubic feet of water. Since about 10 per cent. of the water passes over the edge of the net, and not through it, we may say, in round numbers, that the net strained 600 cubic feet of water in each haul of ten minutes. The material thus collected was preserved in alcohol for future examination.

This examination showed that in every case the take consisted almost wholly of two things. First, there were immense numbers of those minute, microscopic plants, the diatoms, and besides these almost nothing but entomostraca. These entomostraca have not been studied sufficiently to determine the species to which they belong, but a glance suffices to show that they nearly all belong to the one family of *Calanidæ*, which of all our copepoda are best adapted to lead a roving life in deep water and far from shore. In this connection, it is worth while to note that the *Calanidæ* live almost altogether on diatoms and other minute algæ. These algæ, in their turn, get their nourishment from the inorganic matter in solution in the water, matter which the waves wash from the soil along the shore and which the rivers bring down through long distances. If the algæ are thus nourished by the substances in solution in the water, if the *Calanidæ* feed on algæ and the young fish on *Calanidæ*, we have a very pertinent illustration of the conversion of the constituents of the soil into fish-flesh.

After having thus determined roughly the character of the material found in each locality, that obtained at each haul of the net was placed in a graduated glass cylinder and measured.

The following table from my note book is a complete record of the work done:

| NO. | LOCALITY. | DATE, 1893. | HOUR. | SKY. | WATER. | TEMPERATURE OF AIR. | TEMPERATURE OF WATER | DURATION OF TOW. | DEPTH OF NET. | DEPTH OF WATER. | VOLUME TAKEN. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Frankfort 1½ miles out. | Apr. 16. | 10.35 A. M. | Light clouds. | Rough. | ......... | .... | 10 m. | 7.6 ft. | 78 ft. | 5 c.c. |
| 2. | " | " 16. | 11 A. M. | " | Rough. | ......... | .... | " | 34.7 ft. | 180 ft. | 5.6 c.c. |
| 3. | Manitou Islands. | " 17. | 7 A. M. | Cloudy, wind north. | Nearly smooth. | 32° F. top & bot. | 48° F. | " | 24.5 ft. | 30–54 ft. | 7.2 c.c. |
| 4. | " | " 17. | 7 A. M. | Cloudy, wind north. | Nearly smooth. | 32° F. | 48° F. | " | 5 ft. | 30–54 ft. | .3 c.c. |
| 5. | Between Manitou and Fox Islands. | " 17. | 1.45 P. M. | Clear, no wind. | Nearly smooth. | 32° F. | .... | " | 65.1 ft. | 360 ft. | 4.06 c.c. |
| 6. | " | " 17. | 1.45 P. M. | Clear, no wind. | Nearly smooth. | 32° F. | .... | " | Near surface. | 240 ft. | .5 c.c. |
| 7. | Ludington, 2 miles out. | " 18. | 4.45 P. M. | Clear. | Slight waves | 34° F. | 40° F. | " | 10.8 ft. | 60 ft. | 2.1 c.c. |
| 8. | Ludington, 1½ miles out. | " 18. | 5.15 P. M. | Clear. | Slight waves | 33° F. | 40° F. | " | .5 ft. | ........ | .4 c.c. |
| 9. | Ludington, 4 miles out. | " 18. | 6 P. M. | Clear. | Slight waves | 33° F. top 34° F. bot | 38° F. | " | 13.5 ft. | 78 ft. | 3.04 c.c. |
| 10. | " | " 18. | 6.15 P. M. | Clear, sun set. | Moderate waves. | " | 38° F. | " | 6.75 ft. | 78 ft. | 1.85 c.c. |
| 11. | Detroit River, above | " 28. | 4 P. M. | Cloudy. | Nearly calm. | ......... | .... | " | Surface. | 20 ft. | .8 c.c. |
| 12. | Belle Isle Bridge. | | | | | | | | 10 ft. | | 1.2 c.c. |

From this table the following facts appear:

1. That the volume taken at the top is in every case less than that taken at greater depths. Compare, for instance, Nos. 2, 3, 5 with Nos. 4, 8, 11.

A comparison of Nos. 3, 5, 6, taken in the same locality on the same day, seems to show that the volume increases to a certain depth and then again diminishes. At the surface, or a few inches below, there is only .5 c.c. for each 600 cubic feet of water; at 24 feet, there are 7.2 c.c., and at 65 feet, 4.06 c.c. for the same volume of water. This result cannot, however, be regarded as final, since it rests on but one set of observations. It is well known that many of the animals composing the plankton migrate toward the surface at night and seek greater depths during the day, and it may be that the difference between a cloudy and a sunny day produces a corresponding migration.

3. At the same depth, or about the same depth, the volume taken varies with the locality.

The observations refer to four localities:

(a) At Frankfort, Michigan, about one and a half miles from land.

(b) In the neighborhood of the Manitou and Fox Islands, between thirty and forty miles north of Frankfort.

(c) At Ludington, Mich., about fifty miles south of Frankfort, and between two and four miles from shore.

(d) The Detroit River, a few rods above Belle Isle Bridge.

The first three localities cover a stretch of about eighty miles along the east shore of Lake Michigan, near its northern end.

A comparison of the region at Frankfort and the Manitous shows that at corresponding depths there is a larger volume of plankton than at Ludington. Thus, No. 1 at Frankfort, at a depth of 7.6 feet, shows 5 c.c. per 600 cubic feet, and No. 10 at Ludington, at 6.75 feet, shows but 1.85 volumes. No. 3 at Manitou, at 24.5 feet, shows 7.2 volumes, while No. 9 at Ludington, at 13.5 feet,

shows but 3.04 volumes. In the case of No. 1, taken at 10:35 o'clock in the morning, with the sky covered with fleecy clouds, the amount of light was probably at least as great as in the case of No. 10, taken under a clear sky at sunset.

While such evidence cannot be regarded as conclusive, it is, nevertheless, the only evidence now obtainable, and seems to indicate that at Frankfort and the Manitous the plankton is at this time of year about two and one-half times as abundant as at Ludington.

Turning to the Detroit River, we find at a depth of ten feet a volume of only 1.2 c.c. per 600 cubic feet of water, an amount only one-third to one-half as great as at Ludington, and one-fifth or one-sixth as great as at Frankfort and the Manitous.

While more accurate and extended observations might modify the results for Frankfort and Ludington, this is in no way probable in the case of Detroit.

The results mean that white-fish fry would find food only from one-half to one-sixth as abundant at Detroit as at Frankfort, the Manitous or Ludington.

This is only a very imperfect sample of the work that needs to be done. The enormous interest involved in the fisheries of the great lakes and the heavy expenditures incurred in stocking the waters with white-fish and other fry, warrant a most careful and exhaustive examination of the biology of these waters. The problem should be attacked from every side and in the broadest scientific spirit. It is necessary to know accurately the kind of animals and plants inhabiting these waters, the numbers of each kind in a given volume of water, the variations in these numbers due to season, locality and other conditions. It is necessary to know the food of each kind of animal, its enemies and life history. The chemical composition of the water, the changes of temperature, at various seasons and at all depths, should be investigated. In short, every kind of

knowledge that it is possible to record concerning the life of these lakes is of importance. Not until all this has been done can fishculture in the lakes be carried on with a full knowledge of the conditions which it has to meet. The work can not be begun too soon, nor pushed too rapidly or too far.

## DISCUSSION OF PROF. REIGHARD'S PAPER.

PROF. REIGHARD—I want to say a word with reference to the remarks of Dr. Borodine, regarding artificial food for and the raising of these crustacea. The process is this as described by a French writer. He takes dishes perhaps of the size of a tumbler which are filled with cow-dung, and over the top he places a net, and after awhile the diatoms, a few which may be in the water multiply in great numbers so they form a film or coating over this netting, and then any crustacea, he says, which may happen to be in the water feed upon the diatoms and multiply so he gets them in enormous numbers. He suggests the use of that method or something like it for raising this whitefish food. He suggests, for instance, the digging of ponds and the making of troughs running from the shore into ponds, and shoving from the shore baskets or tubs containg cow-dung or other inorganic matter, getting the right plants which will live on that; the plants are diatoms, the dead matter is cow-dung. If the French Government has any secret it must be in the inorganic matter with which you start.

MR. CLARK—Mr. President, I have never stated to the Society nor any one else, what I have done in this process, neither have I ever stated to any member of the U. S. Fish Commission, the Commissioner nor any one else, but I have been working on this process for six years, unbeknown to anybody. But I have failed to do the work that it is claimed they can do. I have been working on the dung process entirely, but I cannot produce the food in any

quantities such as the French people state they can raise. There has been my trouble. I have worked not only with cow-dung, but with horse dung, and I have worked with human dung, but still I cannot get those little things in the quantity I desire. I can get more than I get naturally but I cannot get a pond full that will keep ten thousand yearlings from month to month. I have been doing work according to this process for ten years, and I am about discouraged and ready to give up.

PROF. REIGHARD—These published statements don't give the number.

DR. BEAN—I would like to ask the Professors if these towings mentioned in the paper he has just read were made at any particular time of the day, or whether any difference was found in the plankton or life in the water at different times of the day or in different temperatures of water? Every person who has gone to sea knows that the food of fishes which is so evident at the surface and is known to the fishermen as "seed," "fish seed" or "cayenne," disappears at certain times of the day. At certain times in the day it is on or near the surface and at other times it is down in the water. I should think that the same thing would hold in fresh water. The plankton might be extremely abundant in one belt of water at one time of the day or at a certain temperature, and might be entirely absent at another time; therefore I would like to have the Professor state something about the conditions under which the towings were made.

PROF. REIGHARD—I have those conditions here. They are stated in the paper.

CAPT. COLLINS—Inasmuch as the planting of whitefish fry, which has been enormous, has not apparently given the results that have been anticipated or at least hoped for, I think these facts which are presented by Prof. Reighard are very interesting.

In this connection I would like to hear from the gentle-

men present who have been intimately associated with the whitefish work, as to the localities in which they are usually planted, and whether it is true that they have been put into the lakes in the deepest water, and whether they have been put in localities where they would probably find the best supply of food and the purest conditions of water.

Another thing I have noticed is that he stated that the supply of food found in the Detroit River was somewhat smaller than elsewhere. I would like to inquire if in his judgment this is due to any pollution of the river by drainage or sewerage?

PROF. REIGHARD—I think the determinations were made above the point where the sewers discharge their contents into the stream.

MR. MATHER—I would like to say for the information of Mr. Clark, that some ten years ago I used to go out with the captain of the good ship Hamilton Fish, and he used always to carry his microscope with him, and he worked a good deal on diatoms. He took the dung of the green turtle and he said that was the best thing to grow diatoms in that he knew of. He said I have tried many things but there is nothing to compare with it. He made the remark to me, you could grow lots of oyster food on that if you had the diatoms.

MR. WHITAKER—In answer to the question put by Capt. Collins, regarding the localities in which whitefish fry are planted, I would like to say that, having been identified for a long time with the whitefish work of the Michigan Commission, which has been quite extensive, I am entirely familiar with what has been our custom as to making plants of the fry. We have sought to govern the locality of planting by such light as we have gained from experience, and by the light of reason. We know that certain localities are selected by the parent fish in which to cast their ova, and presumably such localities are the proper ones, and are most likely to be the right places in which

to deposit the young fish. It must be presumed that the food conditions exist in such places which are most favorable to the sustaining of the life of the young fish.

Our statistical agents engaged in the collection of statistics concerning the fisheries of the State are directed to interview the fishermen at all points and to learn from them as nearly as possible the exact locality of the spawning beds, and to carefully note the same, that it may be used for future reference in making plants. This has been done, and as nearly as we can we follow this information in determining where plants shall be made.

The great difficulty concerning this matter is, that such information is to a certain degree unreliable at best, but it is the best we have at present, and is helpful to assist us in determining as nearly as possible the best localities.

In this connection I wish to say you will remember probably that this is one of the questions I have before urged which should be taken up and determined definitely. Every spawning bed of the commercial fishes of the great lakes should be fixed by investigation and by persons qualified to judge by education and training where they are, and these localities so determined should be marked upon charts for the use of the fishculturist.

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## THE FISHERIES EXHIBIT AT THE WORLD'S FAIR.

BY CAPT. J. W. COLLINS.

Mr. President and Gentlemen: I regret exceedingly the short notification I had of this meeting, and the amount of work which has devolved upon me immediately prior to the meeting has made it impossible for me to prepare a paper as I had hoped to do, reviewing the work and

the results connected with the fisheries exhibit at this Exposition. It will not, therefore, be practicable for me to adequately present to you those matters which I had hoped to bring to the attention of the Society.

About two years ago I had the honor of addressing the Society concerning the then proposed fisheries exhibit at the World's Fair in 1893, and viewing it from that standpoint, I had looked forward hopefully to the assembling of collections here which would adequately represent much, if not all, that relates to the fisheries of the world, including the allied industries, such as fishculture, which has come into prominence in recent years, and also the scientific efforts which have been carried on to a greater or less extent in Europe and America in connection with the study of the fisheries and their prosecution.

To say that my ideals have been realized would not be to state the whole truth. When I tell you that in my belief there is not a great Exposition building on these grounds, outside the Horticultural Building, which does not contain something which should be embraced in a fisheries exposition, if it was such pure and simple, you can realize how difficult it has been to draw from those exhibits and to bring together under the roof of the Fisheries Building the things which are now there assembled. In the Agricultural Building you will find fishery products. In Machinery Hall it naturally follows that there are many devices, engines, etc., that are used in connection with fishing vessels or with the fisheries in some other way. In the Manufactures Building are any number of important and beautiful exhibits which would be included under the head of fisheries if this were a fisheries exposition alone. Even in the Mines and Mining Building there is a beautiful exhibit of pearls from Wisconsin, which has been taken there because somebody thought the taking of pearls was mining. In the Transportation Building are many forms of fishing exhibits from various parts of the world

which go to fill in the missing link, so to speak, in lines of transportation, and even in the Arts Building a very considerable percentage of the beautiful paintings that are there, might properly be included under the head of a fisheries exhibit.

I think it is but just to myself to make allusion to these facts which I have mentioned in order; if there are any missing links in the Fisheries Building, they may thus be accounted for. I have not in this enumeration included the exhibit of the United States Fish Commission which stands close to that in the Fisheries Building, for the reason that I have always looked upon that, and I think it has generally been looked upon, as a part of the general fisheries display at this Exposition, and was so intended to be from the first, though it was deemed expedient and best for all concerned that it should be put in the Government Building to be distinctly a national exhibit, an exhibit which would be systematically arranged and would cover in a general way all that relates to the fisheries of this country, as well as to fishculture and scientific exploration as conducted by the national Government.

But, notwithstanding all this, there is reason for some satisfaction in what has been accomplished by the department. It is true that there has been delay in the installation, due to the fact chiefly that certain of our State Legislatures were tardy in making their appropriations, that some individuals did not realize the importance of this Exposition to themselves until near the date of the opening, and to the additional fact that the exhibit from Russia was delayed by being frozen in in the Baltic, and to the fact that those from Brazil have not arrived so early as expected because of some difficulty in getting them shipped from that country. To-day, however, the exhibits are practically completed, and I have much satisfaction in saying that at my request special effort has been made to place in position the exhibits from Russia and Brazil in

order that this Society might examine those collections. They are now nearly ready or in a very advanced stage.

I do not deem it necessary to go over these exhibits in detail to this Society. I believe the most of you gentlemen have had the opportunity of looking at the exhibits and have formed your own opinions regarding them. It may be well, nevertheless, to say in general terms that the exhibits fill the classification as it stands. This classification will embrace subjects of scientific inquiry as well as of fishculture; also the maps showing the fishing grounds and the distribution of species. Following these, it was intended to illustrate the laws and other literature of sea fishing and angling, also to show pictures, emblems and various other things connected therewith. Then we come to the fresh-water fishing and angling, which covers all the various appliances and methods used either for sport fishing or commercial fishing in the great lakes or other interior waters. Following this was a group which embraced the whole subject of the preparation of the fishery products and the products themselves, and last, one including fishculture and scientific study of the matters relating thereto. In various ways the first group has been very completely filled. Not only have we live fish and other forms of aquatic life in the main aquarial building and in the exhibits from Pennsylvania and Wisconsin, but there are innumerable varieties of fish and other animals which are pursued by fishermen, appearing as mounted specimens in casts and represented by paintings and photographs and otherwise. The fishing grounds are also illustrated by certain exhibitors. It is hardly necessary, I believe, to say to any one who has visited the Fisheries Building that the gear of all countries, the apparatus used for capture, is well represented.

A very interesting collection to me is that of the fishing craft, vessels and boats. Not only can we see the rude dug-outs, skin boats and bark canoes which were in use in

this country at the time Columbus discovered this continent, but we also have before us representations of fishing vessels and fishing boats from nearly all countries that are commercially interested in fishing. I deem it a matter for special congratulation that Russia has sent here the largest collection of fishing vessels which I believe she has ever sent anywhere, and Brazil has many things which are unique and interesting, though they are primitive.

As to products and methods of preparation, they are quite as numerously illustrated as the fishing gear. The only thing I have discovered that is wrong in connection with the exhibit is that some visitors entering the Fisheries Building mistake the odor of sea birds and fish for that of nets, lines, etc., and it is not uncommon to see noses put up when they enter the building.

Fishculture is illustrated by some of the States, Pennsylvania and Wisconsin particularly, which not only show representations of the hatcheries, but place before the public the results of the work which has been accomplished by propagation.

Norway, too, has sent models and drawings of her hatcheries and specimens of the apparatus used in fishculture in that country. In the Government Building the United States Commission has a more complete exhibit in this direction, I believe, than has ever been brought together previously, and the actual propagation of fish artificially has been carried on since the opening of the Exposition.

It will be seen, therefore, that the fisheries exhibit, taken as a whole, pretty nearly fills the bill; and though it may not realize all that some of us hoped for, while it may not come up to that ideal which might be fixed, I believe it will prove one of the most instructive object lessons to be found at this Exposition. The importance of this exhibit from an educational standpoint is beyond computation. I have seen children stand with the utmost interest making

inquiries about the live fish, the fishing boats, and I don't know which has the greater attraction for them. I believe all of you realize what an attractive thing a finely rigged model is to a boy. I have been surprised at the intelligence shown by some of the school children in regard to these objects. But it is not alone this fact that makes this exhibit of consequence to us. This is the first fish exposition, if I may be permitted to use the term, that has ever been held in this country, and it is the first opportunity which those engaged in the fisheries and fishculture have had to bring to the attention of the millions of our citizens the subjects in which they are interested, in such a way as to leave a lasting impression. How important that is I need not say. I believe there is no person who does not fully appreciate it. Many of you have been giving the best years of your lives to the work intended to maintain the abundance of fish in our streams, and thereby to improve our fisheries; but you might be surprised if you realized how little comparatively is known of this by the public at large, and how few of our people who are directly dependent for a livelihood appreciate it to its full extent. If, therefore, this exhibit of the fisheries, of fish and fishculture at this great World's Fair tends to improve the knowledge of our people in matters relating to these subjects, then the labor, worry and anxiety which have attended the assembling of these collections and the getting of them into place will not have been in vain. I hope, also, it will be possible for many of our people who are engaged in the commercial fisheries to come here and study the collections which have been so generously brought to this Exposition by the distant countries of the earth. Though we have made many advances in fisheries in the United States, as in other industries, it certainly is not safe for us to assume that we know it all. There may be useful lessons to be learned by making a critical examination of the objects which have been brought here. I was

both pleased and surprised when the exhibit from Norway was being installed to find there was a product consisting of the tanned skin of a fish, one of the commonest fishes we have on the Atlantic coast, which is beautiful, and which we had never thought of utilizing. I observe that Russia also has the same thing, together with various things made of this skin. I refer to the skin of the common wall-fish, as it is called in New England, catfish.

In the department of angling, I think there is much which will interest the disciples of Izaak Walton. I deem it especially appropriate, too, that the gentlemen interested in fishing for sport and in gaining that specially pleasing recreation which can be found only on streams and ponds and lakes and ocean, will see immediately in front of the cases containing rods, reels, flies and the other paraphernalia in which they delight, what the fishculturist is doing to fill the streams and make it possible for the present and future generations to gain health in trying to reduce the numbers of fish in our waters.

This morning we had a very interesting paper from Dr. Borodine showing graphically the relative importance of fishculture as carried on by this and other countries. Those figures speak for themselves, and it needs no words of mine to emphasize them. I may, nevertheless, be pardoned for expressing my feelings on the importance of this work as bearing upon the success of our commercial fisheries and the health and well-being of those thousands who only seek recreation and relief from exhausting work on the banks of our interior waters or along our coast line. To-day we have a large country, sparsely settled in certain sections, but, nevertheless, it is apparent to all of you gentlemen who have been connected with this work that there is danger of depletion of those species of fish which inhabit our interior waters. Our population is increasing at a phenomenal rate, and the day is not far distant when the food of the future man will depend largely

upon the success of the fishculturist; and he will have to thank those of you who are now engaged in this work for laying the foundation sof your work so broad as you have, and for throwing so much effort into the work as you have. Personally, I think the fishermen and the public at large will grow to appreciate this as the years pass by, and if, as I hope, they will join heartily in the work of co-operation, much can be accomplished which now seems impossible.

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## THE ANGLING EXHIBIT AT THE WORLD'S FAIR.

BY DR. JAMES A. HENSHALL.

Mr. President and Members of the American Fisheries Society: As the time is very short, and I speak entirely without preparation, I shall detain you but a moment. Perhaps it would be better were I not to detain you at all, as it is intimated President Harrison is to be here soon.

However, I will state in as few words as possible some of the matters of interest connected with the angling exhibit, drawing your attention to some few things that I would like you to see when you visit it.

The western annex, called the Angling Pavilion, was originally intended to be filled with angling tools and utensils and accessories, but last fall it was thought desirable to give up a part of the room to State exhibits. At present, therefore, only about one-half of the building is occupied by anglers' appliances. I can hardly hope to interest the members of this Society in matters relating solely to angling.

While the exhibit is a small one, it is a very characteristic exhibit of angling goods which are manufactured to-

day, and while it fills the bill, as Capt. Collins has just remarked, it does not fill the building.

In the first place, there is a collection of split-bamboo rods which I believe is the finest collection in the world. And they are practical rods, running in price from $25 to $75, although there are some which, by the addition of gold and silver, will run up possibly to $400 or $500. I desire to specially call your attention to two rods made by the inventor of the split-bamboo rod. Of course, every gentleman here understands the nature of split-bamboo rods. This rod was invented by an old trout fisherman of eastern Pennsylvania, an old gunsmith, who used to fish every Saturday of his life, after he was old enough, and who was a very excellent and fine workman. He used to spend his hours in the evening in his shop making his fishing rods, Uncle Sam Phillipi, and I have two or three of his rods. His first rods were rather rude as compared with rods as now made, but in his day were examples of fine rod making.

Then we have, as I said before, rods running in price from $25 to $75, although you find in the tackle stores rods as low in price as $1.50, but those you understand are made from the cullings of the cane. In the manufacture of split-bamboo rods there are only a few canes in a hundred fit to go into rods of first quality, and it all takes time to sort the canes, and it costs money.

We also have a collection of steel rods which have been brought to a very high state of perfection. There is also a fine collection of bethabara rods. There is also a fine display of reels. We have the finest reels made in this country, and America excels the world in the manufacture of fine goods in this line. We have Kentucky reels of modern make, and we have a collection of old Kentucky reels which are from fifty to seventy-five years old. There you can see the evolution from the first reel made by the old man Snyder down to the present reel.

We have, too, some very pretty girls who make a splendid exhibit themselves, where high flyers can see the fly-tyers. We have a manufactory there of fishing lines that is quite interesting and is well worth visiting. There is a very fine exhibit of baits and trolling spoons, and with this exhibit we have the first trolling spoon that was ever made. In addition to the multiplying reels, we have an automatic reel which is fancied by some fishermen. Of course, there is a large collection of other fishing tackle. In addition to this, we have a collection of literature on angling in the way of books that have been published in this country. There are also exhibited angling trophies, including the largest tarpon ever taken on a rod, the fish weighing 205 pounds, which was taken by a lady, Mrs. Stagg.

There is one thing I did not speak of, a very ingeniously contrived glass cylinder for inclosing a live minnow. The cylinder is surrounded by a *chevaux de frise* of hooks, and of course the glass does not show in the water. In other words, it is "carrying your bait in a bottle." There are several articles in the exhibit which are of interest aside from those of which I have spoken, but I cannot stop to enumerate them all. I would like to call attention, however, to a patent reel-seat, which was invented by our worthy President, as among the things I would like to have you see.

I hope the Society will take occasion to examine all these articles at their leisure.

# FISHCULTURE IN MICHIGAN.

BY HOYT POST.

In this year of reminiscences, it may not be amiss to briefly review the work done in fishculture in Michigan. The record of this work is found in ten biennial reports of the State Fish Commission. This record, presumably like that of other States, shows some blunders, frequent mistakes, and many sad disappointments; but by persistence, energy and pluck, the blunders were overcome and the mistakes corrected, and the disappointments were borne with that Christian resignation which is a characteristic of the craft. As an illustration of this spirit of resignation, a quotation from the Second Report is in point. It says: "Now what is our lake and river farmer to do about it, when accident and insuperable force so confront him? What can he do more than did the honest Dutchman who, when he broke his leg, thanked the good Lord that it was not his neck. Few mortals, if any, can create circumstances, and the fishculturist's work, like all other human work, must take its chances."

The outcome has been a steady and continuous progress, resulting in a fair degree of success.

The Board of Fish Commissioners of the State was established by an act of the Legislature approved April 9, 1873. At this time seventeen other States had embarked upon the work.

The first Board of Michigan consisted of the Governor and the two appointed members, who were to hold office until the expiration of the next regular session of the Legislature. Their duty was stated to be "to select a suitable location for a State fish breeding establishment for the artificial propagation and cultivation of whitefish and such other kinds of the better class of food fishes as they may direct, upon the best terms possible." They were required to appoint a Superintendent of Fisheries of the State, and

to supervise generally the fishing interests and secure the enforcement of all the laws relating to the protection of fish and fisheries in the State. The fact that the whitefish was the only one specifically named in the organic act indicates the regard the people of the State had for this fish, and it has been often since cited as an argument against any neglect of that branch of the work.

The Governor at the time this legislation was enacted was Hon. John J. Bagley, of Detroit, whose interest and appreciation of the work had much to do with the passage of the law, as well as with the public interest in the subject and the early success of the Commission. His associates on the first Board were Andrew J. Kellogg and George Clark, the latter of whom had an experience of almost half a century in catching whitefish in the waters of the State.

The first Board was singularly fortunate in securing as Superintendent the enthusiastic and untiring George H. Jerome, whose spicy and vigorous contributions to the literature of the subject contained in the early reports of the Commission have won the admiration of each succeeding Board and of every appreciative reader.

The salary of the Superintendent was limited by the act to twelve hundred dollars, but the meagreness of the compensation did not hinder this enthusiast from giving to the work all the energy and ability he possessed. He was the life and spirit of the Board so long as he retained his place.

The following words from the First Report of the Commission are deemed worthy of quotation: "The water world, subject year by year to new discovery and to a larger development, may be implicitly relied upon in the years to come to contribute a much larger quota of food than at any pre-existing period. This. as viewed from the fishculturist's standpoint, is believed to be not merely possible, but highly probable. Indeed, this is the fish prob-

lem, nothing more, nothing less; and to the solution of this problem the veteran band of fishculturists, with the appliances at hand, and with a will and courage equal to every conceivable emergency, have gone to work, resolved not to lay down their tools till every promise of theirs is redeemed and every prophecy fulfilled."

The appropriation for the first two years was seventy-five hundred dollars a year. With this fund the Commission established a State hatchery at Crystal Springs, Pokagon, Cass County, on the Methodist camp-meeting grounds, and built a hatchery 20 by 60 feet, one story high, with a roomy attic, and a small residence for the overseer. The earlier efforts of the Commission were devoted somewhat to the propagation and planting of several kinds of foreign fish—the Atlantic salmon, the land-locked salmon, the California salmon and the shad; and we are constrained to believe that much faith and enthusiasm, as well as labor and money, was wasted in the effort to acclimate these foreigners to the waters of Michigan. The whitefish, however, was never overlooked or neglected.

The first plant of whitefish was in the spring of 1874, and it exceeded a million and a half, which was greater than the plant of all other kinds. These whitefish were hatched at the hatchery of N. W. Clark, at Clarkston, Oakland County.

In the spring of 1875, there were hatched at the State hatchery at Pokagon about 150,000 whitefish, and about two millions were bought of N.W. Clark & Son, of Northville, at the price of one dollar a thousand. The plant was upwards of twenty-two hundred thousand.

In the fall of 1876 a small whitefish hatchery, 20 by 50 feet, was built on a leased lot near the water works on Atwater Street, in Detroit, and the experiment tried of using the city water. Oren M. Chase was put in charge of this hatchery. The hatching was done at first in the Holton

hatching-box, for the use of which a royalty of $100 a year was paid.

In the spring of 1876 nearly ten million whitefish were hatched, and the plant in Michigan was nine million three hundred and ten thousand.

The rather boastful mention of this then unparalleled hatch in the Second Report of the Commission is somewhat amusing in the light of what is now being done in that line.

In the organic act provision was made for co-operation with other States contiguous to the waters of Michigan, which should make appropriations for the work and express a desire for joint action; and in the report of 1876 mention is made that several of the States bordering upon the Great Lakes, notably Ohio, Wisconsin and Minnesota, "have got sharply to work upon the whitefish."

The planting of salmon trout was begun in 1875, when one hundred and fifty thousand fry were purchased of N. W. Clark & Son, at the price of two dollars a thousand, and planted in the inland lakes of the State. The work on the Atlantic, the California and the land-locked salmon continued through the seasons of 1875 and 1876. In the meantime, Eli R. Miller, of Richland, had succeeded Governor Bagley as Commissioner, and was made President of the Board, the statute having been so amended as to provide for three Commissioners, one for two years, one for four years and one for six years, and their successors to be appointed to a term of six years each. The appropriations for 1875 and 1876 were seven thousand dollars for each year. Twenty-two States were at this time more or less actively engaged in fishculture.

In 1877, the whitefish plant exceeded eight millions. Some experiments were made in hatching the herring and the German whitefish. In the Third Report the Commission congratulates itself that while it had paid a dollar a thousand for hatching whitefish, it now was producing

them at a cost of not to exceed ten cents a thousand. The Chase automatic jar, an invention patented by Oren M. Chase, had now taken the place of the hatching-box, and was the means of greatly cheapening the production.

The hatching of lake trout and of California salmon and land-locked salmon was continued through the years 1877 and 1878, and experiments were made with the grayling, though with indifferent success. In 1877 the planting of eels was first inaugurated. They were taken in the Hudson, near Troy, and transported in cans.

In the Third Report the Superintendent concludes the California salmon is too large a fish for the great bulk of the inland lakes, and should be planted mainly in the rivers emptying into the Great Lakes. The brook trout work commences about this time at the hatchery at Pokagon, the take being from two to three hundred thousand eggs.

On October 14, 1877, George Clark died, and was succeeded by Dr. Joel C. Parker, of Grand Rapids, who continued as Commissioner by successive appointments until January 1, 1893. He held the office of Commissioner continuously longer than any other member, and gave much valuable work and thought to the subject of fishculture.

The appropriations for the years 1877 and 1878 were seven thousand dollars a year. Twenty-eight States were now engaged in fishculture. The plant of whitefish for 1878 reached the figures of upwards of twelve and a half millions, and for 1879 upwards of fourteen and a half millions. During these two years the work on California and land-locked salmon and trout and eels continued, and two new varieties, the German carp and the California or rainbow trout were introduced.

The appropriations for the years 1879 and 1880 were cut down to five thousand a year. On July 1, 1879, George H. Jerome resigned as Superintendent, and was succeeded September 15, 1879, by James G. Portman, of Watervliet,

Berrien county, and the only one of the old employees retained was Oren M. Chase, who had been overseer of the Detroit hatchery from its start.

Up to this time a considerable plant of whitefish fry had been made each year in several of the inland lakes of the State. No extensive reports of the favorable results of such planting coming to the Commission, the planting was thereafter confined to the Great Lakes and the rivers and straits connecting them, and such interior lakes as contained native whitefish; and thus another undoubted mistake was corrected. The Commission becoming convinced that the brook trout was capable of a much wider range throughout the State than was formerly supposed, began to give additional attention to raising and distributing this popular fish. The Fourth Report bravely suggests that not less than a million brook trout fry should be hatched yearly for Michigan streams.

A few black bass were hatched and planted, and some experiments made in hybridization. Renewed efforts were also made to accomplish something for the grayling, but without success.

About this time the few remaining adult California salmon were turned loose; his exit was preceded by that of the Atlantic salmon, and his by that of the shad, and thus was another mistake corrected. The land-locked salmon struggled along a few years later, but his name has since been stricken from the list.

In the summer of 1880, the Detroit hatchery was remodeled, and the last of the Holton boxes discarded and their places supplied with the Chase jars, giving a total of three hundred jars and a hatching capacity of more than thirty million whitefish fry. Six of these jars were exhibited by Prof. Baird at the International Exposition at Berlin, and Mr. Chase secured the "golden medal of honor" for the invention. About this time the trout and salmon in the ponds at Pokagon began to sicken and die,

and an analysis of the water demonstrated that it was not suitable for the trout work; and thereupon ground and water was rented at Boyne Falls, where through the liberality of Hon. Thos. S. Cobb, of Kalamazoo, a temporary hatchery was located. After one season's use, however, the dam was carried away by a freshet and the hatchery abandoned. The carp were retained at Pokagon for a while, but were soon after removed to Glenwood, where the carp hatchery has since been carried on under the supervision of Mr. Worden Wells, in ponds belonging to him, and with unvarying success.

The whitefish plant for 1880 was ten million six hundred and ninety-five thousand, and for 1881 only three millions. The cause of the falling off was the difficulty in procuring the ova on account of storms, and the failure of the Detroit river fishery, where the fish had theretofore been obtained. About this time the methods of securing the ova were much improved under the suggestion and experiments of Oren M. Chase, who found it feasible to retain the fish in small crates through which the water flowed freely, and to handle the fish from day to day, and take the eggs when ripe, thus making a great saving of the eggs and resulting in but trifling injury to the adult fish.

In July, 1881, the trout station at Paris, Mecosta county, was located on Cheeney Creek, and about 40 acres of land and the meander of the creek 15 rods wide across 120 acres more were purchased.

Here in the early fall of that year was built a trout hatchery 20 by 60 feet, a dwelling house and barn; and the hatchery and ponds at Pokagon were abandoned.

The principal trout work of the State has been conducted at the Paris station ever since without any serious drawbacks. The work, however, has now about reached the limit of the water supply, and one neighboring stream

has already been brought over in pump logs, and it is contemplated doing the same with another.

The whitefish plant of 1882 was upwards of eighteen millions. That spring, the experiment was first made with the wall-eyed pike, and a plant was made of eleven hundred and twenty thousand.

The Board had some difficulty with Superintendent Portman, and in September, 1882, he was succeeded as Superintendent by Oren M. Chase. Mr. Chase served until November 11, 1883, when he was drowned in Little Traverse Bay, while in the performance of his duties, sacrificing his life in his zeal for the work. Walter D. Marks was then made acting Superintendent until March 26, 1884, when he was regularly appointed Superintendent, and continued to act in that capacity until the early part of 1893, when he resigned. Mr. Marks was an early pupil of the veteran Seth Green, and was a man of large experience in handling the breeding fish. He was full of resources and always found some way out of every difficulty that beset his work.

January 1, 1883, Eli R. Miller retired as Commissioner at the expiration of his term, and John H. Bissell, of Detroit, was appointed his successor. The work had reached a somewhat low ebb at this period and needed just such an energetic, thoughtful and practical man as he proved to be, to give it a new impulse. It is no disparagement of any one else to say that Mr. Bissell is entitled to as large a degree of credit as any one for such success as the Michigan Fish Commission has attained.

The appropriation for 1881 was eight thousand dollars, and for 1882 seven thousand five hundred dollars. In the fall of 1883, the work of obtaining accurate statistical information as to the amount and value of the commercial fisheries of the State was commenced in a small way. The whitefish plant of 1883 was twenty-three million seven hundred and thirty-five thousand, and that of 1884, thirty-

seven million seven hundred and fifty thousand. The brook trout plant of 1883 was two hundred and sixty-nine thousand, and that of 1884 was three hundred and fifty-three thousand.

In the Sixth Report it is again urged that there ought to be hatching-house room sufficient for at least a million brook trout. In 1883 a new site was chosen at the corner of Joseph Campau avenue and Lafayette (now Champlain) street, for the Detroit whitefish station. This site is 100 feet square. The lots were rented, and a hatchery 40 by 80 feet built with a shop and barn 30 by 46 feet in the rear along the alley. This building cost about fifty-six hundred dollars, and was equipped entirely with Chase jars. It held 812 jars, with a hatching capacity of about forty-two million whitefish eggs. About this time more land was purchased near the trout station at Paris, and the ponds increased and grounds much improved.

In August, 1883, a whitefish hatching station was established at Petoskey, upon leased grounds, but for various reasons, principally connected with the condition and quality of the water supply, this proved another mistake, and a somewhat costly one, too. Without going into detail, suffice it to say that this hatchery, after being used two or three years, had to be abandoned. As early as 1883, a movement was inaugurated towards the establishment of a whitefish and trout hatching station upon Lake Superior, but it did not result in anything tangible until several years later.

In October, 1883, a meeting was held at Detroit of the Fishery Commissioners of the States bordering the Great Lakes, upon invitation of the Michigan Commission. Commissioners attended from Minnesota, Wisconsin, Ohio and Michigan, and a representative of the United States Fish Commissioner was present. A movement to secure uniformity of legislation led to the consideration of the subject of Federal supervision of the fisheries of the Great

Lakes. At the request of the Michigan Fish Commission, Mr. Otto Kirchner, then Attorney-General of the State, examined the authorities and presented an able brief to the point that the Federal Government had no jurisdiction of the subject, and that such protection as we had must come from the authorities of the several States. This conference was productive of much good feeling, and undoubtedly helped on the work of uniform legislation of the several States bordering the Great Lakes for the protection of the fishing interests.

In February, 1883, a Secretary of the Board was appointed for the first time. Herschel Whitaker was appointed and served until June 1, 1884, when he resigned and Andrew J. Kellogg succeeded him. Mr. Kellogg served until March 20, 1888, when he was succeeded by George D. Mussey, who has served ever since. On the resignation of Mr. Kellogg as Commissioner, to take the appointment as Secretary, Mr. Whitaker was appointed Commissioner in his place, and has continued in office to the present time. The combination of Mr. Whitaker, Mr. Bissell and Dr. Parker made a strong Board, and from this time on a new impetus was given to the work. The business was organized and the work classified and systematized as it never had been before. Through their influence larger appropriations were obtained and the work extended in every department.

The Commission in 1884 obtained control of one of the fisheries on the Detroit river, and this policy has been extended until now they control all the fisheries on the American side of the river.

The Sixth Report sums up the condition of fishculture in 1884 as follows: "The present aspect of this subject is far different in many respects from what its advocates and promoters of ten or more years ago believed it would be at this time. The general enthusiasm of the early movement as it seized upon the naturalist and sportsman

of ten or fifteen years ago in the blush of its first successful experiments has not entirely faded away, but has ripened into a deep conviction on the part of an ever-increasing number of intelligent men, that fishculture has solved one half of the question, Can the fisheries be preserved? and has now settled down upon business-like principles and methods to do its part. The other half of that question must depend for its answer upon wise measures for protection. This is true of almost every State and Territory in the Union." The appropriations for 1883 and 1884 were ten thousand dollars for building and equipping new stations, and ten thousand dollars a years for current expenses.

In August, 1885, Mr. Lyman A. Brant was appointed statistical agent for the Board and visited all the commercial fisheries of the State, and made a full report in writing of his work, which was much the best of its kind that had thus far been done, and afforded the Commission much needed information.

The whitefish plant for 1885 was forty millions, and for 1886 was sixty-one million six hundred and twenty thousand; a few Loch Leven trout were planted and the plants of California trout were continued, but the adult fish did not do well in the stock ponds, and many of them were liberated. Further experiments with the grayling were continued; a large portion of a grayling stream was stocked with them and barriers erected to prevent their escape, and every inducement provided for them to spawn in a semi-wild or natural state, but the experiment was a failure. Additional ponds were built at the Paris station and the grounds otherwise improved by grading and sodding. Further agitation was given to the question of the Upper Peninsula whitefish station. A scheme of systematic examination of all the inland waters of the State seriatim was inaugurated. For this purpose a double crew of men was sent into the field, and charts of each lake examined

were made and filed in the office, to be bound in books. These charts contain a rough sketch of the shape of the lake, give their name and location, dates of examination, kind of bottom and shores, temperature at top and bottom and surroundings, number and kinds of fish caught and how, their condition and what feeding upon, the kinds and condition of fish food in the water, and recommendation as to kinds of fish to plant. This work has been continued each year until at present there are complete records of upwards of four hundred lakes which have been examined, the reports of which are bound together in volumes indexed and easy of reference. These volumes are consulted in passing upon applications for fish plants in the waters.

The capacity of the trout hatching house at Paris has already reached a million and a half, and a new house is recommended to increase the capacity to three and a half millions.

The hatching and planting of whitefish, brook trout, lake trout, wall-eyed pike, carp, Loch Leven trout, landlocked salmon and California trout was continued through the years 1887 and 1888. In 1887 the first plant of German trout was made, and the rearing of this fish has been continued ever since and much increased in later years. It seems to thrive in Michigan waters and has every appearance of being a hardy and a vigorous importation.

In 1887 a new additional trout hatching house 40 by 82½ feet was built at Paris, at a cost of about $4,000 for the house and fittings. The old hatching house was dismantled, but remains standing and is used for a store house and shop. It is capable of being restored and put in commission again on short notice and at small cost, if needed. The capacity of the Detroit whitefish house was increased by the addition of the jars removed from Petoskey, so that it now contains 525 jars, which would hatch eighty to ninety millions of whitefish a year.

In 1888 the Commission had a car built for transporting fry and fish. It is over 55 feet long and substantially built, with passenger coach trucks, air brakes, platforms, coupler and buffers, so that it can be easily hauled in any passenger train. It has an office at one end and a kitchen at the other, and is fitted with five berths, enabling the men to live and sleep on the car. Its capacity is 175 cans. It is named "Attikumaig," the Chippewa name for the whitefish, meaning literally the "deer of the water." This car has proved a great convenience, and has been the means of cheapening the distribution of fish and fry. It has been in continual use from February till the latter part of June of every year since it was built. The plant of whitefish in 1887 was seventy-two million nine hundred and eighty-four thousand, and in 1888 about the same number. The brook trout plant in 1887 reached one million, and in 1888 was over a million and a half. The wall-eyed pike plant of 1887 was three million two hundred and eighty thousand, and in 1888 eleven million four hundred and ninety-two thousand.

Mr. Bissell's term of office expired January 1, 1889, and Hoyt Post, of Detroit, was appointed his successor. On March 20, 1888, Mr. Kellogg resigned as Secretary, and the present Secretary, George D. Mussey, succeeded him.

In 1888 and 1889, the Secretary made trips of investigaion of the fisheries and filed written reports, which are printed in the biennial reports of the Commissioners. In January, 1890, Mr. S. C. Palmer continued this work on a more extended scale. During the years 1891 and 1892, Mr. Charles H. Moore engaged in similar work for the Commission and obtained complete reports of every fishery in the State, his work being as complete as could be made. Experiments were made in hatching sturgeon eggs, and a few were successfully hatched. A successful hatch was also made of the eggs of white bass. These eggs are very small and hatch in about forty-eight hours.

Subsequently larger quantities were successfully hatched in the Chase jar.

The Commission has made several fish exhibits, embracing nearly all varieties of native fish, at the State Fair and the Detroit Exposition, and elsewhere. These exhibits were comparatively inexpensive and were very attractive, and proved valuable aids in disseminating knowledge of fish and fishculture. The Report of 1890 was the first illustrated Report issued. It contains cuts illustrating the hauling of the seine, and the stripping of fish, and interior and exterior views of the hatcheries, and of the ponds and grounds at Paris, which added much to the attractiveness of the Report.

Some attention now began to be given to scientific work, and Prof. Jacob Reighard, of the University of Michigan, began his investigation of the development of the wall-eyed pike. The motive that first led to this investigation was the discovery of the cause of the large percentage of loss in hatching the eggs of this fish, as compared with those of the whitefish. He made extended microscopical examinations and accompanied the men in the field and followed the eggs to the hatchery and watched their development and hatching. He reduced his observations to writing, furnishing an article of upwards of 60 pages, with microscopical drawings, which was published in the Ninth Report, with plates and drawings. This article is regarded as a most valuable contribution to the literature of fish-culture and has been in great demand. Prof. Reighard also conducted like experiments with whitefish eggs. He also accompanied the crews for examination of waters with his microscopes and an assistant and a botanist, and made quite extensive examinations of the fish food and aquatic plants, and incidentally of some fish parasites. He also prepared a still more elaborate article on the development of the embryo of the wall-eyed pike, covering about eighty pages, which with the plates illustrating it are pub-

lished with the Tenth Report. He is at present inaugurating some experiments connected with the food of the whitefish, and its life and abundance, and when and how distributed, which it is hoped will be of value in determining the proper places for planting the whitefish fry. It is designed to make this examination as careful and exhaustive as the means at hand will allow, and it is planned to interest the authorities of the University of Michigan, to co-operate with the Commission in extending work of this scientific nature from time to time. No work of the Commission has attracted wider attention among intelligent readers than the work already done by Prof. Reighard.

A boiler and pump were added to the Detroit hatchery for use in case of an emergency causing the stoppage of the flow of the city water, such as had been once or twice experienced. By this means the water in the storage tanks could be on short notice pumped up into the troughs which feed the hatching jars and keep the water circulating through the eggs until the stoppage of the regular flow of the city water ceased. The storage tank capacity of the hatchinghouse was also nearly doubled by enlarging the wing of the building.

In the summer and fall of 1889, the efficiency of the Detroit whitefish hatchery was doubled by the erection of two additional frames of jars, which increased the number of jars in place to one thousand and fifty, with a hatching capacity of nearly two hundred millions; but the difficulty of obtaining sufficient ova to fill the jars prevented for a year or two reaping the full benefit of the increased capacity. The whitefish plant in 1889 was sixty-three millions, and in 1890 one hundred million seven hundred thousand. The wall-eyed pike plant of 1889 was forty-four million three hundred and forty thousand, and in 1890 twenty-two million three hundred thousand. The brook trout plant of 1889 was two million four hundred and sixty-

eight thousand, and in 1890 two million five hundred and seventy-eight thousand. The appropriations by this time had increased to upwards of twenty thousand dollars a year, and the inventory of the property of the Commission showed a valuation of upwards of thirty-five thousand dollars.

The Tenth Report covers the years 1891 and 1892, and is a substantial volume of 228 pages. In the fall of 1891 a small hatchery for whitefish, lake trout and brook trout was established at Sault Ste. Marie, containing 200 jars, besides such hatching troughs as the space in the building would admit. The city paid the rent of a small store building in which this hatchery was set up, and furnished city water free. This hatchery was run during the seasons of 1891 and 1892, but owing to difficulty and disappointment in procuring whitefish ova, was not filled until 1892. The purpose of a whitefish hatchery on Lake Superior, was to provide for stocking that great lake; the hatch at the Detroit house coming too early to be planted on account of the ice in the harbors.

It was thought that the difference in the temperature of Lake Superior water would retard the hatch about two or three weeks, which proved to be the fact. The water at the Sault proved admirably adapted to the work, both of hatching whitefish and brook trout. The temperature of the water is remarkably even and cold. It began November 15, at 42°, and for the month ensuing varied from 42° to 38°, and about January 1, ran down to 34°, where it remained without variation to exceed one degree either way until April 20, and from then until May 15 it did not go above 40°. A daily record of the temperature of the water is kept at each station while in operation.

The appropriations for 1891 and 1892 exceeded $27,000 a year, and those just granted for the years 1893 and 1894 are $25,000 a year. The inventory of the property has increased to nearly $38,000.

Never till the fall of 1892 had the Detroit hatchery been completely filled with eggs. In that year the Commission controlled all the fisheries on the Michigan side of the Detroit river, and instead of letting them out to others to fish, hired the fishermen and absolutely controlled and directed the fishing.

Through the energy, persistence and skill of the Superintendent, W. D. Marks, in conducting this work, more fish were caught and more eggs taken than had ever been before. The total number of whitefish caught was 13,074, the total eggs taken was 4,544 quarts or 142 bushels, making 173,630,400 eggs. It was a beautiful and inspiring sight to look upon the tiers of jars in the Detroit house, more than a thousand in number, all filled and in active operation. It is a sight never equalled elsewhere and but once there.

The whitefish hatchery at Detroit is undoubtedly the largest, best arranged, best equipped, most economical and most efficient in the world. No other has begun to compete with it in out-put. And there are few, if any, brook trout hatcheries that excel the one at Paris.

The whitefish eggs are placed in the jars in November and December, and remain from 130 to 140 days, or until March and April, before they hatch; and the fry are no more than out of the way before the same jars are filled with the eggs of the wall-eyed pike, which are placed in the jars in April and May, and hatch in 28 or 30 days, coming out the last of May and first of June.

It has been the habit of the Board for the past few years to hold regular monthly meetings and such special meetings as may be found necessary, and full records are kept in writing, in bound volumes, of the proceedings, including everything of interest in fishculture which comes to the attention or knowledge of the members from time to time.

Full books of account are kept of all the money transactions. All payments are by checks signed by the mem-

ber of the auditing committee who certifies to the account, and vouchers in duplicate are taken for all payments. William A. Butler, Jr., of Detroit, has been Treasurer of the Commission since about 1883.

Bound volumes are kept of the statistical reports and examining crews. All applications for fish are in writing on printed blanks furnished, which describe the location and character and temperature and soundings of the water, and the surroundings where it is proposed to plant the fry.

In January, 1893, the term of Dr. Parker expired and Horace W. Davis, of Grand Rapids, was appointed his successor.

In December, 1892, an International Fish Conference was held at Detroit, under the auspices of the Michigan Commission. There were present Samuel Wilmot, of Ottawa, Canada; Edward Harris, of Toronto; Thomas Marks, of Port Arthur; and W. S. Wells, of Chatham, Ontario, and members of the Fish Commissions of New York, Ohio, Minnesota, Maine, and many others from different States, including some fishermen. The subjects discussed were connected with uniformity of legislation protecting fish and game, and more particularly the vital question of a close season for the commercial fish. The main results of the meeting were embodied in a report of a committee which was adopted as follows, viz:

"1. That all small fish and others unfit for food of all kinds, when taken in nets, should be replaced in the waters when taken alive; that fishermen should not be allowed to take such fish on shore nor expose them for sale.

"2. That no strings of pound nets used in the lakes shall extend more than four miles from shore.

"3. That one-half part of all channels between islands or elsewhere—where fish migrate to spawn, shall be kept free from nets of all kinds at all seasons.

"4. That all whitefish taken of less than sixteen inches in length, and all salmon trout less than two pounds in weight, shall be immediately returned to the waters where taken and shall not be exposed for sale.

"5. That the month of November in each year be made a close season for whitefish, herring and salmon or lake trout.

"6. That all penalties fixed for violation of any laws that shall be enacted shall be made not only to apply to those who take fish, but also to all persons who buy, sell, transport or have the same in possession."

The following resolution was also passed, viz.:

"*Resolved*, That the law should authorize the seizure and destruction of nets used in violation of law."

Throughout all the ten reports of the Commission are frequent acknowledgments of courtesies and exchanges with the Commissions of other States, and especially with the United States Commissioner, to whom the Michigan Commission is under many and acknowleged obligations for continued favors and grants of eggs and fry, and fish of varieties that could not be elsewhere procured.

The Michigan Commission would be guilty of gross ingratitude and lack of appreciation if it ever permitted any account of its work to go forth without due acknowledgment of its obligations to the railroads of the State, without whose aid, given for the asking and without stint, it could never have accomplished anywhere near what it has.

Ever since the organization of the Commission it has at each legislative session given much time and attention to procuring the passage of proper protective legislation to preserve the fisheries; but it seems much easier to get legislation through to propagate fish than to lay any restrictions upon the catching. As against any such restrictions an active and not over-scrupulous lobby always appears on the scene, and cries out about the ruin and destruction of

their property and investments, and who ever knew a legislature that was proof against such a plea.

Appended to this article is a complete table of the totals of all plants of fish of all kinds that have been made by the Michigan Commission, taken from their Tenth Report:

TOTAL PLANTS OF BROOK TROUT IN FOURTEEN YEARS.

| | | | |
|---|---|---|---|
| 1879 | 12,000 | 1886 | 719,000 |
| 1880 | 50,400 | 1887 | 1,090,000 |
| 1881 | 388,500 | 1888 | 1,639,000 |
| 1882 | 251,000 | 1889 | 2,468,000 |
| 1883 | 219,000 | 1890 | 2,578,000 |
| 1884 | 353,000 | 1891 | 2,500,000 |
| 1885 | 408,000 | 1892 | 2,422,000 |
| Total | | | 15,097,900 |

The above is a statement of the plants of brook trout made from the Paris station from and including 1879, the year in which the trout work of the Commission was removed from Pokagon to Paris.

TOTAL PLANTS OF WHITEFISH.

| | | | |
|---|---|---|---|
| 1874 | 1,532,000 | 1885 | 40,000,000 |
| 1875 | 2,211,500 | 1886 | 61,620,000 |
| 1876 | 9,310,000 | 1887 | 72,984,000 |
| 1877 | 8,001,000 | 1888 | 72,968,000 |
| 1878 | 12,520,000 | 1889 | 63,000,000 |
| 1879 | 14,545,000 | 1890 | 109,700,000 |
| 1880 | 10,695,000 | 1891 | 104,000,000 |
| 1881 | 3,000,000 | 1892 (from Detroit station) | 65,500,000 |
| 1882 | 18,170,000 | 1892 (from Sault Ste. Marie station) | 9,724,000 |
| 1883 | 23,735,000 | | |
| 1884 | 37,750,000 | | |
| Total | | | 740,965,500 |

TOTAL PLANTS OF WALL-EYED PIKE.

| | | | |
|---|---|---|---|
| 1882 | 1,120,000 | 1889 | 44,340,000 |
| 1884 | 2,040,000 | 1890 | 22,300,000 |
| 1886 | 1,806,256 | 1891 | 27,045,000 |
| 1887 | 3,280,000 | 1892 | 57,300,000 |
| 1888 | 11,492,000 | | |
| Total | | | 170,723,256 |

TOTAL PLANTS OF CARP.

| | | | |
|---|---|---|---|
| 1881 | 1,093 | 1889 | 3,490 |
| 1885 | 2,088 | 1890 | 5,798 |
| 1886 | 3,422 | 1891 | 2,231 |
| 1887 | 2,843 | 1892 | 2,025 |
| 1888 | 3,878 | | |
| Total | | | 26,868 |

### TOTAL PLANTS OF ATLANTIC SALMON.

| | | | |
|---|---|---|---|
| 1873 | 21,350 | 1874 | 139,000 |
| Total | | | 160,350 |

### TOTAL PLANTS OF CALIFORNIA TROUT (FRY).

| | | | |
|---|---|---|---|
| 1880 | 12,000 | 1889 | 4,000 |
| 1884 | 6,000 | 1890 | 16,000 |
| 1885 | 25,000 | 1890 (adults) | 475 |
| 1887 | 20,000 | | |
| Total | | | 83,475 |

### TOTAL PLANTS OF SWISS LAKE TROUT.

| | |
|---|---|
| 1890 | 17,360 |

### TOTAL PLANTS OF LOCH LEVEN TROUT.

| | | | |
|---|---|---|---|
| 1885 | 8,000 | 1890 | 30,000 |
| 1888 | 5,000 | | |
| Total | | | 43,000 |

### TOTAL PLANTS OF BROWN TROUT.

| | | | |
|---|---|---|---|
| 1889 | 20,000 | 1891 | 156,000 |
| 1890 | 60,000 | 1892 | 271,500 |
| Total | | | 507,500 |

### TOTAL PLANTS OF LAKE TROUT.

| | | | |
|---|---|---|---|
| 1875 | 150,000 | 1886 | 490,000 |
| 1877 | 168,500 | 1889 (two years old) | 13,000 |
| 1878 | 433,834 | 1890 " " " | 467 |
| 1879 | 379,000 | 1892 (from Sault Ste. Marie station) | 204,000 |
| 1880 | 26,500 | | |
| 1885 | 215,000 | | |
| Total | | | 2,080,301 |

### TOTAL PLANTS OF SCHOODIC SALMON.

| | | | |
|---|---|---|---|
| 1876 | 20,300 | 1885 | 48,000 |
| 1878 | 26,000 | 1886 | 23,000 |
| 1879 | 4,867 | 1887 | 23,636 |
| 1880 | 20,000 | 1888 | 73,424 |
| 1882 | 13,517 | 1889 | 5,000 |
| 1883 | 27,874 | 1890 | 44,000 |
| Total | | | 329,618 |

### TOTAL PLANTS OF CALIFORNIA SALMON.

| | | | |
|---|---|---|---|
| 1873 | 45,900 | 1878 | 73,000 |
| 1874 | 419,930 | 1879 | 215,246 |
| 1875 | 323,000 | 1880 (adults) | 575 |
| 1876 | 227,000 | | |
| Total | | | 1,304,651 |

### TOTAL PLANTS OF EELS.

| | | | |
|---|---|---|---|
| 1877 | 265,000 | 1883 | 236,000 |
| 1878 | 405,000 | 1885 | 325,000 |
| 1879 | 317,000 | 1891 | 273,000 |
| 1881 | 390,000 | | |
| Total | | | 2,211,000 |

### TOTAL PLANTS OF BLACK BASS.

| | | | |
|---|---|---|---|
| 1880 | 3,500 | 1888 | 1,560 |
| 1881 | 7,000 | 1890 | 185 |
| Total | | | 12,245 |

### TOTAL PLANTS OF WHITE BASS.

| | |
|---|---|
| 1891 | 2,500,000 |

The aforesaid biennial reports contain detail statements of the place of each plant, date of delivery and to whom, and amount of each.

From the annexed table it will appear that the total plants of whitefish aggregate the large number of nearly seven hundred and fifty million, commencing in 1874 with little above a million and a half. The twenty million point was not reached until 1883, the fifty million point until 1886, nor the hundred million point until 1890, so that more than half the whole number have been planted within the past five years.

It is matter of deep regret to every one connected with or interested in the artificial propagation of whitefish that actual and tangible demonstration of the results of such large plants, cannot in the nature of things be obtained. The results of brook trout planting in streams are so open to inspection and so easily observed and appreciated that

it is not difficult to convince any caviller by proofs and demonstration that cannot be gainsaid; but to reason from analogy it would seem that if the relatively smaller output of brook trout has produced such remarkable results as they are known and acknowledged to have, the millions of whitefish and wall-eyed pike that have been planted in the Great Lakes must have made a marked impression on the commercial fisheries, and yet frankness compels the admission that thus far the increased catch of adult whitefish is not at all commensurate with what it seems ought to have been expected as the outcome of these great plants. It is true there are many things to be taken into account in this matter, not the least of which is the slaughter of immature fish; but it would be very gratifying if the actual outcome of these plants could be proved as it can with the plants in the streams.

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## A SUGGESTION:

## THE SPECIALIST IN FISHCULTURE.

BY W. DAVID TOMLIN.

In all lines of business, the specialist has become a factor. In engineering circles the specialist is called in to examine the plant before it is started, even though a consulting engineer has supervised the construction all through.

In electric engineering, after the contract is completed, a specialist carefully examines the entire system; not alone to test the efficiency, but to look for the most economic methods of operating the system.

Specialists are not confined entirely to the medical profession. The demands of American business life call for the most improved systems that can be devised to furnish

our people with food and comfort; with the best of raiment, with homes adorned with all that is beautiful, and replete with such surroundings that will conduce to the lengthening of our days, and to take off the sharp edge of erroding care that so stealthily eats into the life of even the strong man.

Among the tasty tid-bits that so many enjoy is the planked whitefish—the *Coregoni* of Lake Superior—becoming year by year a scarcity.

The States west of Lake Superior—Minnesota, the Dakotas, Montana, Colorado and Iowa—demand whitefish early in the season, and continue the demand as long as there are possibilities of getting them. In all these Western States they are staple articles of fish food when they can be procured; but the decrease is rapid, and unless some means are devised to restock the waters that formerly produced them, the fishermen will not find a school of such fish in a single season's catch.

At present we are dependent upon Canadian fishermen to largely supply our Western markets. We are brought to face the subject, American fishermen cannot get whitefish within one hundred miles of their home ports, and year by year the nets and boats have to go further up into Lake Superior to find any whitefish for the home market, let alone the demand for the same fish for the market in the States west of us.

Mr. Milner sounded the notes of warning: "That the whitefish were decreasing in 1872." At that time the fishermen could get nets fairly well filled with them in Lake Superior waters within 12 to 20 miles of Duluth; today the fishermen must go 160 miles up into the same lake to get any of these fish, and if the ice is late in breaking up and going out, the fish have visited the grounds and departed before the fishermen get to the fishing grounds. These fish visit Isle Royale late in the fall to spawn, and

the only large catch of whitefish must be made at that time, or the fishermen get none during the season.

The question arises and is often discussed with some vigor, is there no remedy for this state of affairs? Cannot Lake Superior be restocked with whitefish?

There are two points worthy of consideration. One is a national law demanding that the fishermen shall be compelled to strip and deposit the spawn of the whitefish, just as the State laws of the State of Wisconsin demands and enforces.

Another point is, the employment of specialists that shall go out with the fishermen during the spawning season and teach them to carefully handle the fish and impregnate the eggs, and then interest the fishermen in the work so as to deposit the eggs in the best places to secure food for them when hatched.

Fishermen are often charged with carelessness, destroying young fish, by using meshes too small to let the smaller fry escape. I have not so found them, from some years' experience with them. I have learned that measures looking to the introduction of larger mesh nets have been considered, and a bill was introduced into the State Legislature demanding the increase of the size of meshes full $\frac{3}{4}$ of an inch string measure; in matters pertaining to the development of fishing interest these men are alive, and look to their own interests.

This measure of securing an expert or a "specialist" to spend one or two seasons with the fishermen on the Great Lakes during the time the fish are spawning, and to get them interested in the best manner of propagating fish fry, came from men who have been obliged to go out of the fish business, because there is no money in the business; their capital stock lay too long idle and no means of remuneration offered them—"They must make hay while the sun shines"—and the whitefish fishing became so poor they perforce sought other occupations.

Perhaps I am asked, Have any of the fishermen ever attempted to spawn fish, and if so, what were the results?

Yes, more than half a dozen of them; for results I will give a report to a gentleman connected with the Fish Commission:

"One of our men who lives up the lake quite a long ways, always spawns all the fish he finds that are in a fitting condition to be stripped, and has done so for five years; the result is he sends fish uniform in size, and more in quantity, and perhaps has not to go so far to catch fish as any other men who send fish to us. The lake within a few miles of his home is a splendid fishing ground. While other grounds have been fished out, this man is prosperous, intelligent, and is making money right along. Now, if he can do this with lake trout, why cannot other fishermen be taught to strip and spawn whitefish?"

This is not an isolated case; at Fishermen's Home on Isle Royale there is another fisherman who has been stripping fish as they came in ripe, and depositing the impregnated spawn. The captain of one of the fishing tugs has attempted the stripping of ripe fish and carried a tin bucket for this purpose; these three of the half dozen have perhaps been the only ones who have kept up the practice, but the mass of the fishermen have at different times urged the necessity of planting the spawn on the grounds where nature has provided food for the young fry when hatched.

Does some one ask, Is there a necessity for incurring this expense? Does not the increasing demand for this foremost of all fishes for table use justify the demand for some extra expense? Does not the decreasing numbers of these fish call for some extra efforts to replenish the waters formerly prolific with them?

Does not the fact that tugs come into port the first week in June, and report the fishing "played out" demand that

something be done to provide for the restocking of the whitefish grounds?"

Is it not sufficient to convince any thinking mind, that six years ago, four steam vessels hailed from this port [Duluth], and scoured the fishing grounds of Lake Superior for lake trout and whitefish; while at the present date there is but one steam tug engaged in the fishing business, and before the middle of June, this is coming in with but half catches, and announces that the fishing is about gone up for this season.

It is useless to send out men to gather spawn, who cannot resist the impulse to *sit down vigorously* when a boat is rolling. It is more than useless to send out men to gather spawn, who will made a fire on the beach, *and sit and warm themselves*, while the fishermen are either coaxed or bluffed into getting spawn for them. If fishermen can be taught to gather spawn, then by all means let the experiment be tried. It is better to let fishermen attempt to gather spawn, and realize 40 per cent. for the quantity gathered, than to have men sent out for this specific purpose, go to sleep in the pilot house of the tugs; while the fishermen dump such eggs that are taken into a bucket, nilly willy, leaving the eggs to the chances of impregnation.

Fishermen have made successful spawn takers, have raised 80 per cent. of the spawn so taken, and brought out strong, healthy fry; what one fisherman has done, others can be taught to do.

Then by a careful selection of sober, industrious men, apt to learn, quick-witted, of habits of thought capable of improving their surroundings, with fingers that follow the impulses of their minds, and who by their earlier experiences can stay in a rolling boat and secure eggs, without paying tribute to the genii of the unsalted seas by casting up their last meal.

The situation demands some thought of fishculturists.

Should we stand with folded hands, and see this denizen of these great lakes pass into the records of the U. S. Fish Commission, while the coming generation shall say, That was an age that consumed, but did not produce.

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## SALE OF DOMESTICATED FISH.

BY W. F. PAGE.

If the subject on which I now address you needs apology it may be found in the first Article of the Constitution of this Society. Therein it is stated among other things that the object of this Society is "to promote the cause of fishculture, and the uniting and encouraging of the interests of fishculture."

During the past three years, my attention has been several times called, more forcibly than ever before, to the harassing restrictions placed by several of the States upon fishculture when conducted as a private enterprise. I have reference to the clause existing in the laws of several States prohibiting the sale of artificially reared fish within the close season prescribed for the protection of wild fish.

In the framing of many of the protection laws of the States it would seem that folly had joined hands with wisdom. For these protective laws were in themselves the direct outgrowth of the repeated earnest recommendation and solicitation of fishculturists. It cannot be believed that it was any part of the intention of the solicitors that laws should be enacted or so constructed as to harass, hamper and strangle fishculture. It is unreasonable that any State fostering fishculture at State expense in maintaining hatcheries under the plea of furnishing its citizens

with cheap and healthful food, should in substance say to a tax-paying citizen, "You must not sell your artificially reared fish to our people until such time as Dame Nature can furnish us the same article." By its creation and maintenance of a Fish Commission, empowered to restock the streams, the State recognizes the desirability that its people should have an abundant, cheap food; and by its imposition of a tax on private fishcultural establishments it says, in effect, that the business is legitimate; but all this is unsaid when it denies to the taxed industry the right to sell its products in accordance with the demands of the market. It is worse than taxation without representation, it is taxation with strangulation. The error consisted at the time of framing the laws in not recognizing the vast possibilities of fishculture for supplying the market demand, in not distinguishing between wild trout and those artificially raised. Some of the States promptly modified their laws. But it is amazing that others persist in refusing to distinguish between State property and private property. If the expansion of fishculture so earnestly wished and worked for is ever to be realized in America, this stumbling block of over-protection must first be removed. As a step toward the consummation of this end I offer for your consideration the following:

At a meeting of the American Fisheries Society, held in Chicago, May 15, 1893, the following preamble and resolutions were presented:

*Whereas*, The cultivation and raising of trout as a food product being now an established industry in many of the States, furnishing employment to individuals, profitable investment for capital, and food for the people, and whereas the business is capable of great expansion, thereby furnishing the people with a food product of the highest class, and whereas the object of this Society is to encourage the cultivation of useful fishes as a food product, and

whereas this Society views with regret the laws of several States which interfere with the above industry ;

*Resolved*, That this Society favors legislation which will permit the sale and possession for food of trout and other useful fishes, which are artificially raised in private ponds and streams, at any time when within the provisions of the health ordinances.

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## WHAT WE KNOW OF THE LOBSTER.

BY FRED MATHER.

Within a few years much has been learned of the life-history of our common lobster that we did not know before. We knew that the female carried the eggs after extrusion, attached in masses to the so-called swimerets under the abdomen, which is improperly called the "tail," and that they hatched there. In Bell's "British Crustacea" it is said that the mother cares for the young after hatching and can recall them for protection. My own observations are that the young scatter and find protection in the rocks.

I am satisfied that the lobster carries her eggs all winter, and that all those laid after the middle of July, in Long Island Sound, will not hatch the same year, but eggs taken late last year afford a chance to give some figures which may be of value. On August 11, 1892, we took from 12 lobsters 43 fluid ounces of eggs, which by actual count measured 6,000 to the ounce, and on August 16 took from 33 lobsters 94 ounces, making in all 822,000 egg or 18,266 per lobster. We could not keep these eggs all winter, and they showed only slight developement a month later.

No work that has occupied the attention of fishculturists compares with what may be done in replacing the lobster

industry on the footing which it held in comparison to the population of the country 40 years ago. Then, a lobster of five pounds was a small one, now, one half of that weight is large, and the numbers have decreased in even greater proportion. The only things that approach the utility of lobster culture in economic importance is the hatching of whitefish on the Great Lakes, and the shad in the rivers; the trout and salmon will not compare with the lobster in value, if the latter can be increased as the former have been.

It is possible to bring this neglected branch of fishculture to a point where it will, on the seaboard, at least, overshadow the other branches in which we have been engaged.

After making notes about lobsters carrying their eggs all winter, when laid after July 15, I received the following letter from Prof. Samuel Garman, of the Museum of Comparative Zoölogy, Cambridge, Mass., dated August 30, 1892:

Mr. Fred Mather:

Dear Sir: I am very glad to get your reports and to know that you are pushing inquiries into the life-history of the lobster and the fishes which you propagate. I take pleasure in sending you a little report of my own on the lobster.

Very truly, S. Garman.

To say just how I rejoiced to find that Professor Garman's studies confirmed my own crude observations is beyond my power. It is pleasant to have one's ideas confirmed by any one who has studied the subject more than he has; but I will quote Prof. Garman's paper entire:

## REPORT ON THE LOBSTER.

By S. Garman.

Museum of Comparative Zoology,

Cambridgde, Mass., Dec. 17, 1891.

*Hon. E. A. Brackett, Massachusetts State Fishery Commissioner:*

Sir:—Yours, with inquiries regarding the conclusions reached in the study

of the lobster, is at hand. While unavoidable delay in the drawings prevents placing the complete matter in your hands, it is quite possible to give you in a few words a general idea of the results and their bearings, such as will no doubt sufficiently answer your questions.

According to the arrangements made, some of the eggs from berried lobsters kept for the purpose were sent me at regular intervals through an entire year. These eggs were at once examined to note their progress in development, and they were then preserved by various methods for future studies and comparisons. After their young were hatched the females themselves were dissected, to observe the condition of the ovaries, and to determine the time when another lot of eggs might have been expected from them. As our work began in midwinter, it was necessary to follow certain specimens up to the hatching, and then to take others to complete the series from the laying. Eggs supplied me as freshly laid were so far advanced as to indicate that fertilization had taken place before they were placed under the tail of the lobster bearing them. The time and process of fertilization has not been discovered; but in all likelihood the marine lobster does not differ greatly in these respects from its fresh-water relatives, the crayfishes. In the case of the latter the male seeks the female some time before the eggs are laid, and deposits the fertilizing matter on the upper side of the body, near the external openings of the oviducts, where it adheres for a time as a whitish mass. How the fertilizing elements, the spermatozoa, come into contact with the eggs and enter them, has not yet been observed. The development of the embryo in eggs laid on the seventh or eighth of August was so rapid that on the third of September the eyes were visible as thin crescent-shaped spots. As the waters grew colder the progress was retarded, until the changes were very slight indeed. This condition was maintained throughout the winter, and it was only when the summer temperature was reached that rapidity of advancement was again to be noted. The young began to hatch on the fourteenth of July; all of the eggs on a female seeming to be about equally advanced, the entire brood emerged at very nearly the same time. Examination of the ovaries, after their young had left, showed that the females would not have laid eggs again for a year; that is, not before the summer next following that in which they had hatched a brood. In other words, the dissections proved that the lobster lays only once in two years, hatching a brood one summer and laying eggs the next following summer for another brood. The time required in the development of the embryo is so long as to preclude hatching the eggs under ordinary circumstances during the summer in which they are laid. Artificial conditions might readily be brought about, by heating the water in which the specimens are kept, which would hasten the progress and greatly shorten the period between laying and hatching; but normally the winter temperature induces an almost complete suspension of advancement.

By the small number of specimens kept, it was not possible to fix the lengths of either the laying or the hatching periods. This, however, may be approximately done in connection with observations made by the United States Fish

Commission. It must be borne in mind, in this connection, that the seasons south of Cape Cod begin earlier and last longer than in Massachusetts Bay, and that further north they will be still more contracted. Variation must also be expected in different years, as the seasons are earlier or later, and in different localities, as the waters are warmer or colder. Though the bulk of the laying or of the hatching in any particular year occurs within periods of two or three weeks, probably four-fifths of either is finished in less than a fortnight; to make allowance for the early years and for the late ones, and to include the early and the belated individuals, it becomes necessary to considerably extend the general periods.

From all that has been gathered we may summarize as follows: (1) The female lobster lays eggs but once in two years, the layings being two years apart; (2) the normal time of laying is when the water has reached its summer temperature, varying in different seasons and places, the period extending from about the middle of June till about the first of September; and (3) the eggs do not hatch before the summer following that in which they were laid, the time of hatching varying with the temperature, and the period extending from about the middle of May till about the first of August.

I have the honor to be, very respectfully yours,

S. GARMAN.

This represents all that is known of the life-history of the lobster to-day. Our plants from the eggs taken July 8, 1892, were made on July 12, 18 and 20, and was probably the last of the eggs laid the summer before. I do not believe that "the lobster lays eggs all the year round," as has been said. The animal leaves the "crawls" in cold weather and seeks a depth where the temperature is higher, and the lobstermen shift their pots in accordance with this migration.

In a two-column article the *Scientific American* of April 9, 1892, went over this subject, and from that I make the following extracts:

During the past ten years there has been a great falling off in the supply of lobsters, until the price has increased fully one hundred per cent. This applies alike to the New York market, to the waters along the New England coast and in Canada and Newfoundland, where lobster fishing and canning is an important industry. The necessity for increasing the supply of lobsters is generally recognized, and two methods are proposed for accomplishing this object. One is the enactment of laws which will check the depletion of the lobster beds by over-fishing and the other is artificial propagation.

Marshall McDonald, who is at the head of the United States Fish Commis-

sion, says: "I have always felt that the maintenance of the lobster fishery rested more essentially upon proper regulation of the matter by the States than upon any efforts in the way of artificial propagation. The most usual regulation is that prohibiting the sale of lobsters below certain dimensions; the mininum limit, though varying with the different States, being smallest in Massachusetts In Maine, where the law is enforced and the minimum fixed, I believe, at ten inches, the result has been a marked improvement in the lobster fisheries during recent years."

A law was enacted by the New York Legislature in 1880, prohibiting the taking of lobsters smaller than ten and a half inches, but it was repealed, largely it is said, by reason of the efforts of a hotel keeper in New York city with political influence, who was determined to serve small lobsters on his table, regardless of the effect of rescinding the regulations.

The difficulty of securing legislation on this subject of enforcing the laws when they are enacted, and preventing their repeal through the efforts of persons who have no regard whatever for the consequences of their acts, compels those who desire to see the supply of this wholesome food fish kept up, to look to artificial propagation as the most available method for securing the object desired.

For three seasons lobsters have been hatched in small numbers at the station of the New York Commission, Cold Spring Harbor, L. I. The embryos are very delicate, and when lobsters are placed on ice, as many are which come to market, the embryo is generally ruined for hatching purposes.

Fred Mather, Superintendent of the Cold Spring hatchery, and a man of wide experience in fish propagation, said recently that lobsters were not only decreasing in numbers, but also in size. A two-pound lobster was now considered a fair average.

New York is next to the largest receiving market for lobsters in the country, yet the lobster fisheries within the boundaries of the State are not now important, and are confined to eastern Long Island. In former years lobsters were found in large numbers in New York Bay and at Hell Gate. The disappearance of this food fish is due mainly to over-fishing, but also to the establishment of manufactories, which have polluted the waters. Lobsters were taken at Robbin's Reef, New York Bay, as late as 1879, but they were small and were not exposed for sale.

Lobsters are sold in New York during the entire year, but the demand is five times greater during July, August and September than during any other three months of the year. The demand is the least during February and March. The consumption of lobsters at Coney Island in summer reaches 3,500 pounds a day.

The experience on the coast of Maine seems to be similar to that already stated. In 1890 twenty millions of lobsters were taken, which was a falling off of five millions or twenty per cent. from the catch of 1888 and ten per cent. from 1889. There has also been a steady decrease in the size of the fish sent to market. During 1889 and 1890 the average length of lobsters offered for

sale was 10½ inches, and the average weight two pounds. Ten years ago the average length was 13 inches and the weight three and one-half to four pounds. There are thirty-six factories on the coast of Maine where lobsters, sardines, herrings and mackerels are packed.

When it is remembered that the eggs which we get would be sent to market, boiled with the lobsters and thrown away with the shells, it will be seen what may be done in lobster culture with proper facilities. The lobster is easier to catch than a rabbit, for it has less sense, and when it sees a lobster pot with its bait, it seems to have found a haven of rest—and it has.

The decrease of the number of lobsters from Newfoundland to New Jersey, has been accompanied by a decrease in size, and a corresponding increase in price per pound. In proof of this I will again quote from the *Scientific American:*

The depletion of the lobster fisheries has been especially noticeable in Canada. The report of 1888 showed a decrease in the value of exports of $350,000, as compared with the previous year, although there had been an advance in the price of 25 per cent. The value of the Canadian lobster fishery in 1888 was $1,483,388; in 1886, $2,638,394; in 1885, $2,613,731.

Could figures speak plainer than these?

Up to June 11, this year, we have planted 85,350 young lobsters, and have on hand 510,000 eggs.* We cannot keep the young many days, because they are cannibals, and as they moult about three times in the first ten days and are then soft, their brethren devour them. I have fed them crab and lobster meat, clams and beef, with the hope of bribing them to refrain from eating their fellows, but did not succeed. They are persistent cannibals and must be put out at a few days old on rocky bottom, where there are always hiding places for a soft lobster to remain until his skin hardens into a new and larger shell.

*The plant for the year 1893, was 176,945. Most of the late eggs did not hatch.—F. M.

# CONSTITUTION.

## ARTICLE I.

NAME AND OBJECTS.—The name of this Society shall be "The American Fisheries Society." Its object shall be to promote the cause of fishculture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of the interests of fishculture and the fisheries; and the treatment of all questions regarding fish of a scientific and economic character.

## ARTICLE II.

MEMBERS.—Any person shall, upon a two-thirds vote and the payment of three dollars, become a member of this Society. In case members do not pay, their fees—which shall be three dollars per year—after the first year, and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote the of members present, at any regular meeting.

## ARTICLE III.

OFFICERS.—The officers of this Society shall be a President and a Vice-President, who shall be ineligible for

election to the same office until a year after the expiration of their terms; a Corresponding Secretary, a Recording Secretary, a Treasurer, and an Executive Committee of seven, which with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

ARTICLE IV.

MEETINGS.—The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or in default of such action, by the Executive Committee.

ARTICLE V.

CHANGING THE CONSTITUTION.—The Constitution of the Society may be amended, altered, or repealed, by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said meeting.

# MEMBERS

OF THE

# AMERICAN FISHERIES SOCIETY.

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## Honorary Members.

Behr, E. von Schmoldow, Germany; President of the Deutschen Fischerei verein, Berlin, Germany.

Borodine, Nicholas, Delegate of the Russian Association of Pisciculture and Fisheries, St. Petersburg, Russia.

Borne, Max von dem, Berneuchen, Germany.

Huxley Prof. Thomas H., London; President of the Royal Society.

Jones, John D., 51 Wall Street, New York.

St. Clair Flats Shooting and Fishing Club, Detroit, Mich.

Anglers' Association of Eastern Pennsylvania.

## Corresponding Members.

Apostolides, Prof. Nicoly Chr., Athens, Greece.

Buch, Dr. S. A., Christina, Norway; Government Inspector of Fisheries.

Birkbeck, Edward, Esq., M. P., London, England.

Benecke, Prof. B., Conigsberg, Germany; Commissioner of Fisheries.

Brady, Thomas F., Esq., Dublin Castle, Dublin, Ireland; Inspector of Fisheries for Ireland.

Chambers, Oldham W., Esq., Secretary of the National Fishculture Association, South Kensington, London.

Day, Dr. Francis F. L. S., Kenilworth House, Cheltenham, England, late Inspector-General of Fisheries for India.

Fedderson, Arthur, Viborg, Denmark.

Giglioli, Prof. H. H., Florence, Italy.

Hubrecht, Prof. A. A. W., Utrecht, Holland: Member of the Dutch Fisheries Commission, and Director of the Netherlands Zoological Station.

Ito, K. Esq., Hokkaido, Cho., Sapporo, Japan; Member of the Fisheries Department of Hokkaido, and President of the Fisheries Society of Northern Japan.

Juel, Capt. N., R. N., Bergen, Norway; President of the Society for the Development of Norwegian Fisheries.

Landmark, S., Bergen, Norway; Inspector of Norwegian Fresh Water Fisheries.

Lundberg, Dr. Rudolph, Stockholm, Sweden; Inspector of Fisheries.

Macleay, William, Syndey, N. S. W.; President of the Fisheries Commission of New South Wales.

Maitland, Sir J. Ramsay Gibson, Bart., Howietown, Stirling, Scotland.

Malmgren, A. J., Prof., Helsingfors, Finland.

Marston, R. B., Esq., of London, England; Editor of the *Fishing Gazette.*

Olsen, O. T., Grimsby, England.

Sars, Prof. G. O., Christina, Norway; Government Inspector of Fisheries.

Smith, Prof. F. A., Stockholm, Sweden.

Sola, Don Francisco, Garcia, Madrid, Spain; Secretary of the Spanish Fisheries Society.

Solsky, Baron N. de, St. Petersburg, Russia; Director of the Imperial Agricultural Museum.

Trybom, Filip, Dr., Stockholm, Sweden.

Walpole, Hon. Spencer, Governor of the Isle of Man.

Wattel, M. Raveret, Paris, France; Secretary of the Societie d'Acclimation.

Young, Archibald, Esq., Edinburgh, Scotland; H. M. Inspector of Salmon Fisheries.

## New Members.

Armstrong, C. E., Toledo, Ohio.
Blair, Joseph H., Omaha, Nebraska.
Davis, H. W. Detroit, Michigan.
Dean, Dr. Bashford, Columbia College, N. Y.
Jones, Alexander, Wood's Holl, Mass.
Ravenel, W. de C.

## Members.

Adams, Edwin W., 14 Wall Street, New York.
Adams, Dr. S. C., Peoria, Ill.
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